QUARTERLY REPORT NO. 5

(FOR PERIOD ENDING NOVEMBER 30, 1975)

ENVIRONMENTAL BASELINE DATA COLLECTION

AND

MONITORING PROGRAM

FEDERAL PROTOTYPE OIL SHALE

LEASING PROGRAM

TRACTS U-a and U-b

UTAH

WHITE RIVER SHALE PROJECT

TN
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United States Department of the Interior

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February 6, 1976

The attached report is the fifth of a planned series of reports from the Federal Oil Shale Lessees to the Area Oil Shale Supervisor describing progress under approved exploration and baseline data plans.

The purpose of these reports is to provide interested parties with a review of ongoing operations and a summary of the data being collected. Because of the sheer volume of data being generated, these reports should be considered as the first (overview) phase of planned data distribution. Parties interested in reviewing more detailed data on specific portions of the program should contact the Area Oil Shale Office in Grand Junction where such data will be kept on file.

We would appreciate receiving any comments or suggestions you may have concerning these reports.

Peter A. Rutledge
Area Oil Shale Supervisor

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I. INTRODUCTION

This document is a summary of work conducted as part of the environmental baseline monitoring program from September 1, 1975, to November 30, 1975. The baseline program is being conducted in accordance with the "Partial Exploration Plan, Environmental Baseline Data Collection and Monitoring Element," submitted July 1, 1974, and the Conditions of Approval developed by the Area Oil Shale Supervisor (AOSS) for various sub-elements of the program. As requested by the AOSS, the field data collected for this quarterly period have also been submitted and are on file in the AOSS office in Grand Junction, Colorado. This summary report presents an overview of these data and has been organized and correlated with prior quarterly reports.

This report presents a partial interpretation and analysis of one year's data for the surface and ground water and air resources baseline monitoring programs. Analysis and interpretations of all baseline monitoring and data collection programs will be reported in the First Year Environmental Baseline Report presented as a separate document to the AOSS with the submittal of the Detailed Development Plan.

The completed geologic subsidence program, and the aesthetics programs are also summarized.

II. WATER RESOURCES

A. WORK COMPLETED

1. SURFACE WATER

Data analysis on the complete first year's data began for the annual baseline report. The second year of baseline monitoring began with revisions to the program still awaiting approval.

2. SURFACE WATER QUALITY

Surface water quality samples were collected as scheduled. Analysis of samples was delayed until finalization of contracts between VTN, the state of Utah, and the USGS.

3. GROUND WATER LEVEL MONITORING

The ground water level monitoring program continued through the quarter along with the continuous water level and monthly measured water level programs. As reported last quarter, the continuous monitoring equipment was removed during the aquifer test program in favor of manually measured water level responses to aquifer test pumping.

4. GROUND WATER QUALITY

Samples were collected from the aquifer test pumping wells this quarter as per previous agreement with the AOSS. The regularly scheduled semi-annual pumped sample program was begun in mid-November and was concluded in mid-December.

5. AQUIFER TEST PROGRAM

The aquifer test program was initiated in late July and was concluded in mid-September with the aquifer being tested at four well sites--P-1, P-2 upper and lower, and P-3. Static water levels were monitored for several days at and around the sites prior to test pumping to establish water-level trends.

B. DATA SUMMARY

1. SURFACE WATER

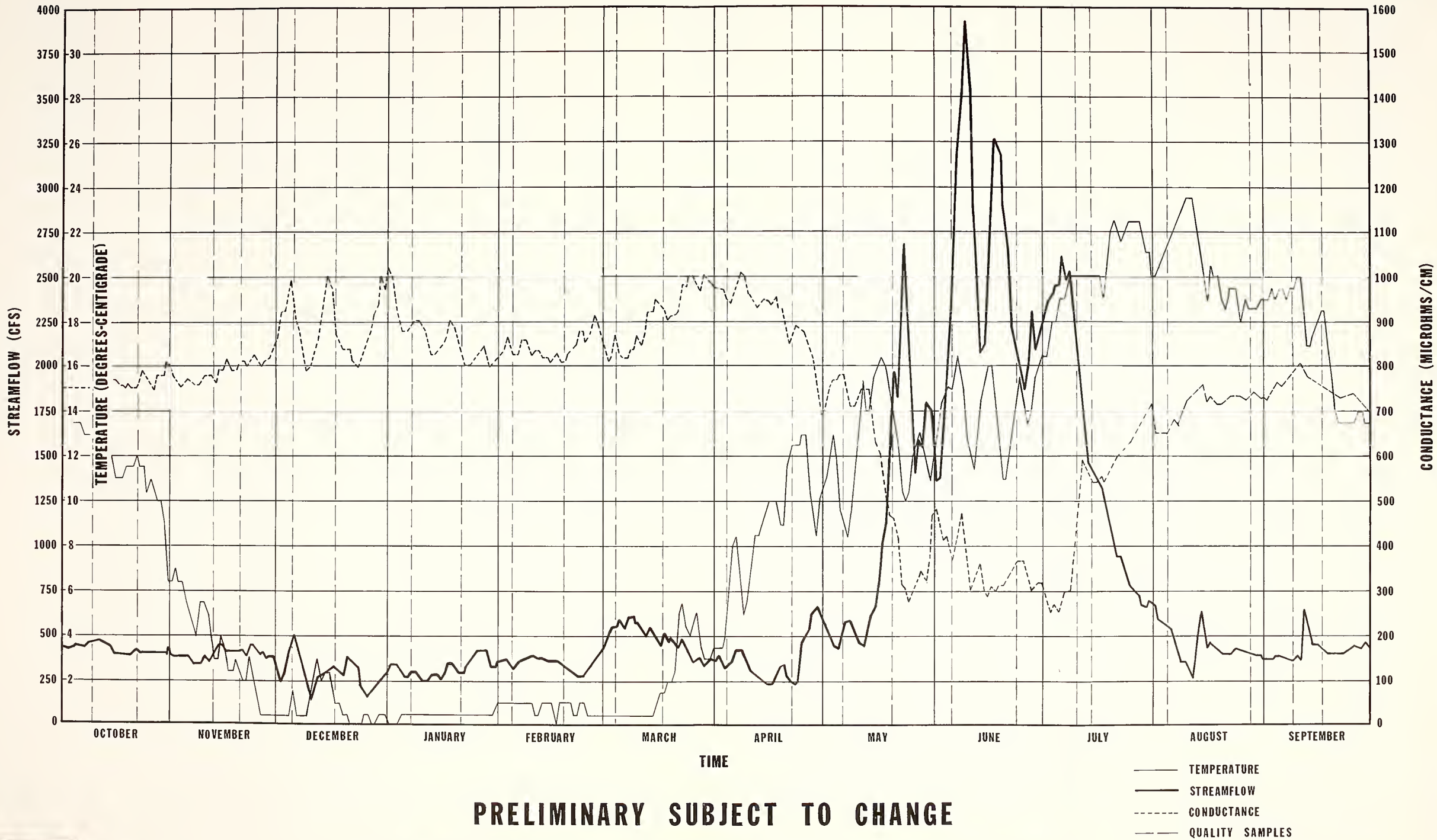
a. White River

Figures II-1 through II-4 show the mean daily temperature, streamflow, and specific conductance for the four stations on the White River. The streamflow records of all four stations are similar, with differences probably caused by channel changes rather than to flow variations, since the widest differences occur during high-flow periods, when channel scouring occurs. The temperature and specific conductance plots for all four stations are also similar, as expected. Flow during the year was slightly above normal (Table II-1). Although streamflow during the base-flow period was less than average, runoff from snowmelt during May, June, and July was more than sufficient to make up the difference. The August and September data show a return to the baseflow period as flow decreased and conductance increased.

b. Evacuation Creek

Streamflow, temperature, and conductance of Evacuation Creek all varied widely during the high flow-period, although the variations between the three stations are fairly consistent. (See Figures II-5 through II-7.) High flows were still being measured during September. The peak flows in Evacuation Creek are very short lived, indicating they are the direct result of surface runoff from thunderstorms or periods of rapid snowmelt. The station farthest upstream, S-7, showed sustained flows well above the base-flow from April through June. (See Figure II-5.) The flows at the lower stations (S-6 and S-2) were similar, but neither was consistently higher or lower in flow (Figures II-6 and II-7) than S-7. Variations between stations are probably the result of channel changes but may reflect interactions between the stream and the aquifer.

Specific conductance varied inversely with streamflow and remained fairly constant from one station to another. Water temperatures followed the seasonal air temperature variations, with the lowest values in January and the highest in July and August.



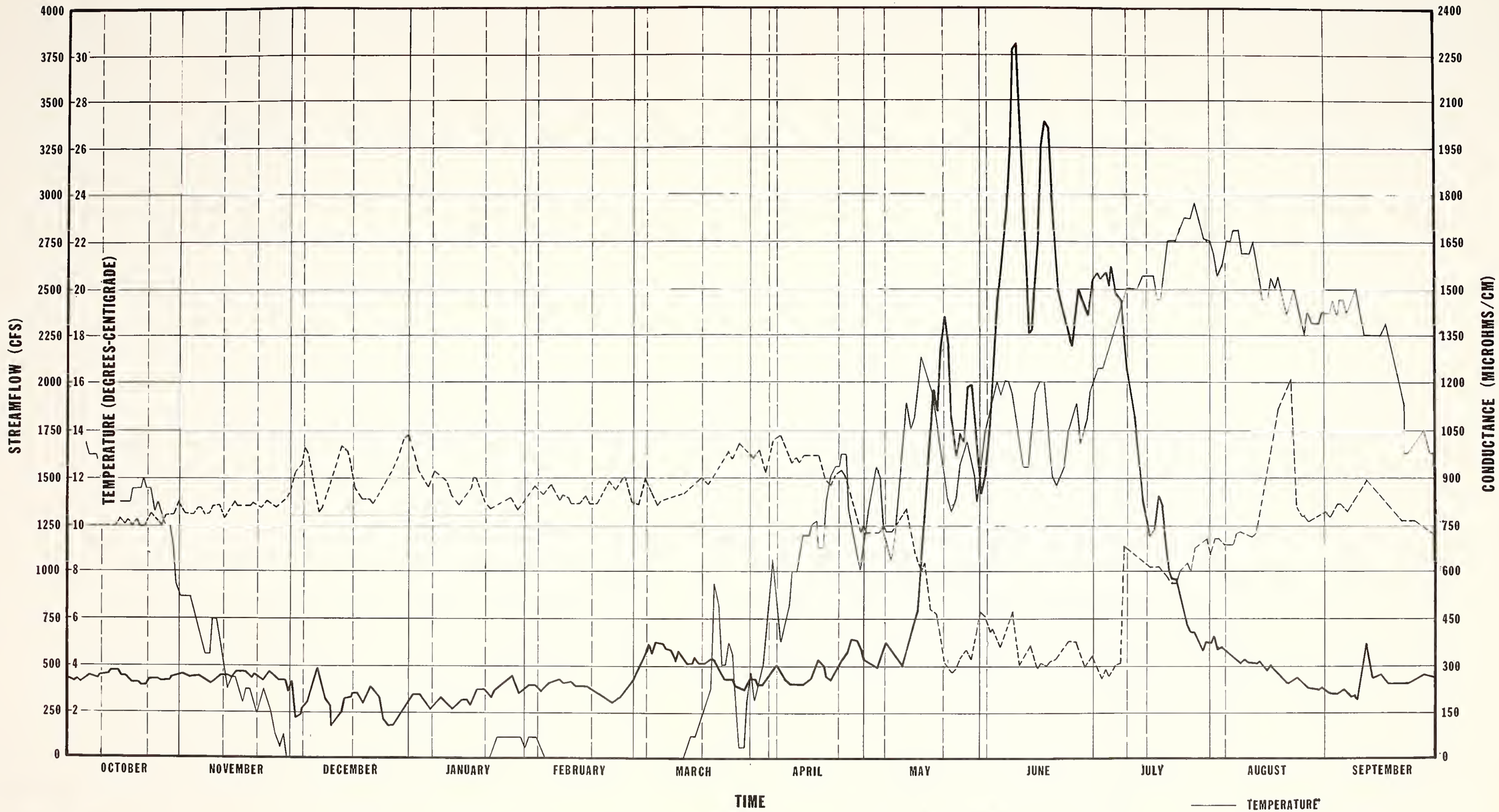
PRELIMINARY SUBJECT TO CHANGE

MEAN DAILY TEMPERATURE, STREAMFLOW AND SPECIFIC CONDUCTANCE

WHITE RIVER ABOVE HELLS HOLE CANYON - (S-1)

OCTOBER 1974 - SEPTEMBER 1975

FIGURE II-1



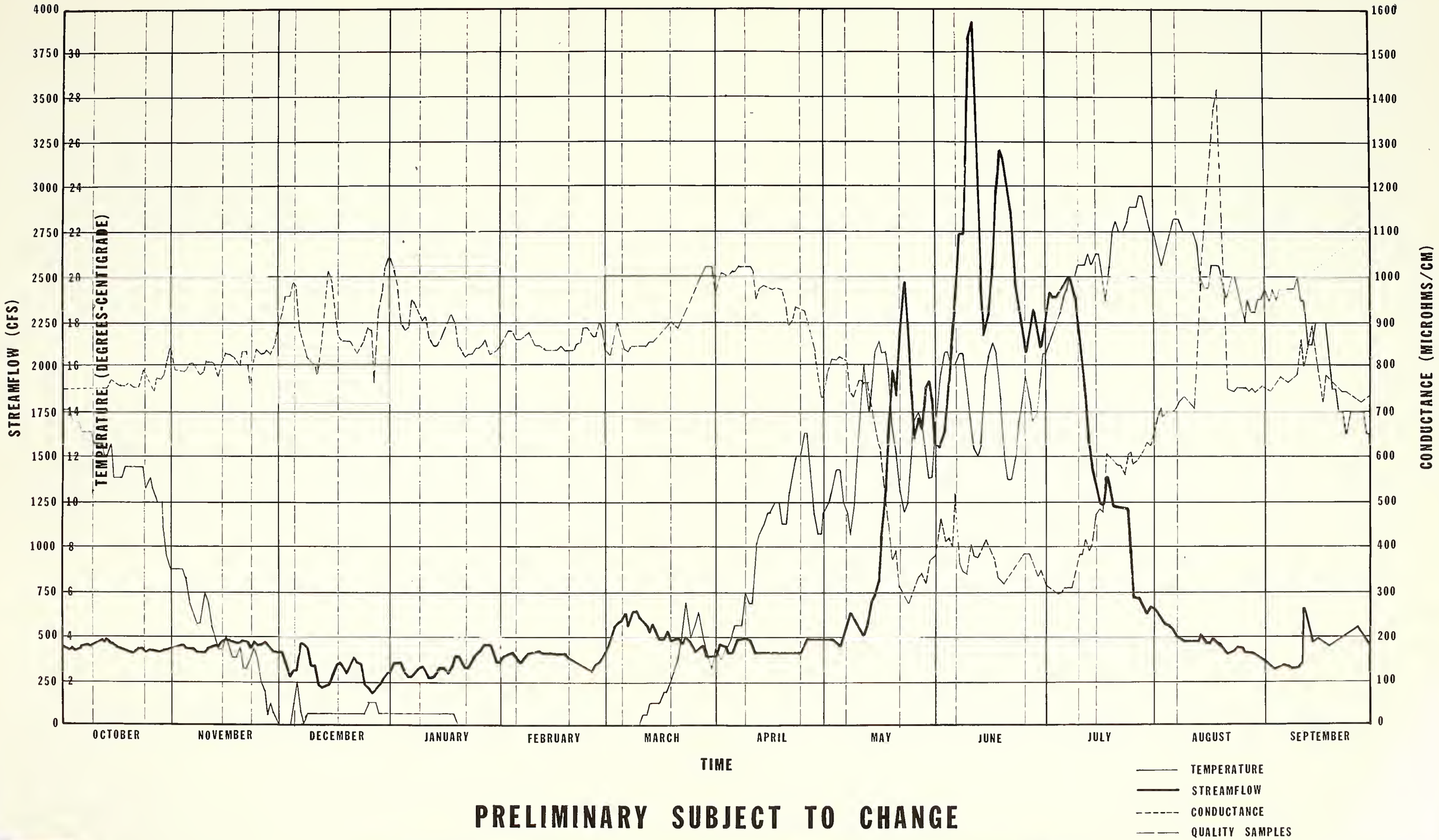
PRELIMINARY SUBJECT TO CHANGE

MEAN DAILY TEMPERATURE, STREAMFLOW AND SPECIFIC CONDUCTANCE

WHITE RIVER NEAR WATSON, UTAH - (S-3)

OCTOBER 1974 - SEPTEMBER 1975

FIGURE II-2

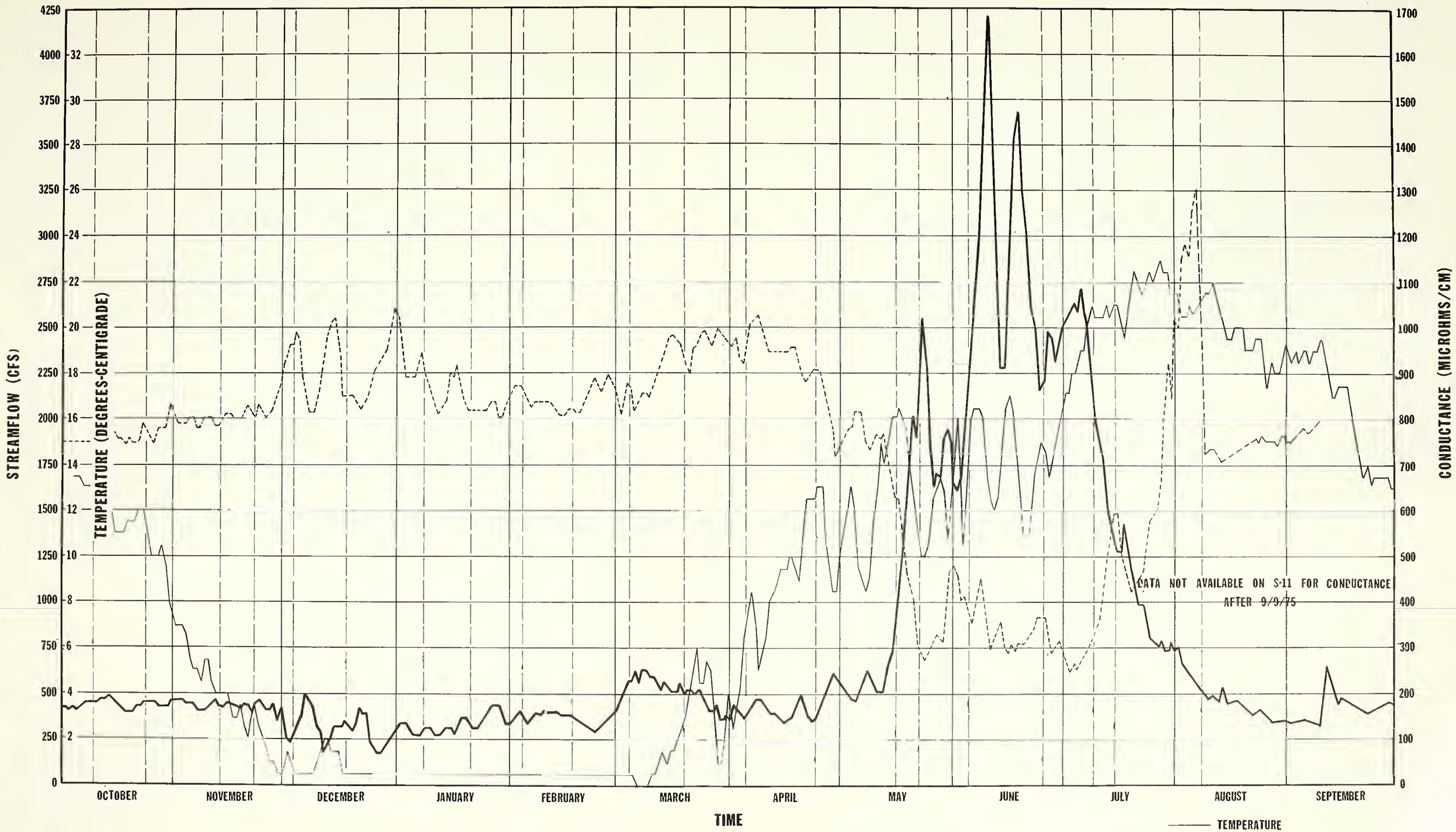


PRELIMINARY SUBJECT TO CHANGE

MEAN DAILY TEMPERATURE, STREAMFLOW AND SPECIFIC CONDUCTANCE

WHITE RIVER ABOVE SOUTHAM CANYON - (S-4)
OCTOBER 1974 - SEPTEMBER 1975

FIGURE II-3



PRELIMINARY SUBJECT TO CHANGE

MEAN DAILY TEMPERATURE, STREAMFLOW AND SPECIFIC CONDUCTANCE

WHITE RIVER BELOW ASPHALT WASH - (S-11)

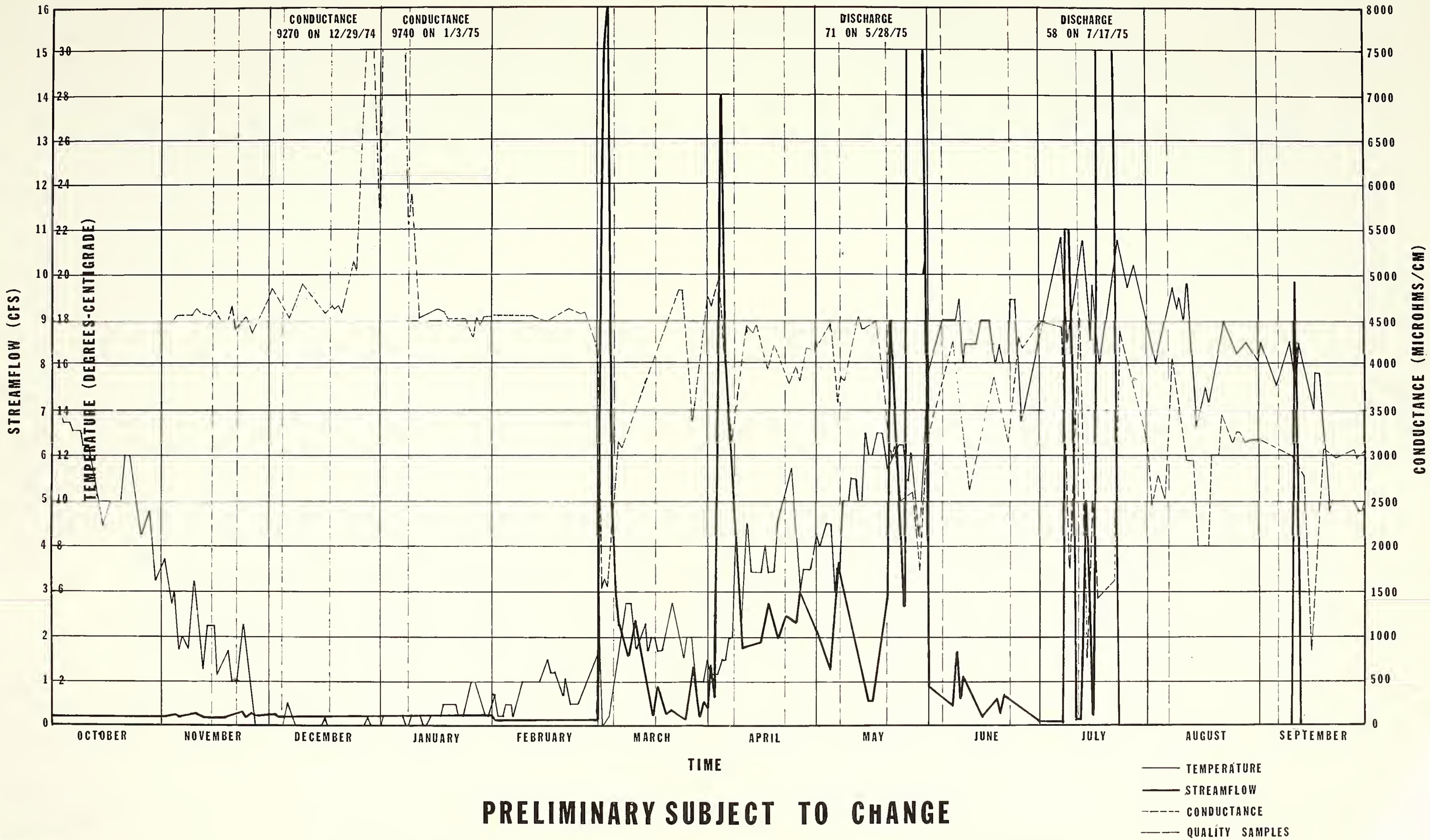
OCTOBER 1974 - SEPTEMBER 1975

FIGURE II-4

TABLE II-1

MEAN MONTHLY STREAMFLOW
WHITE RIVER NEAR WATSON (S-3)
IN m^3/s
(cfs)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Historic Flow (1904-1974)	13.80 (466)	11.70 (413)	10.31 (364)	9.97 (352)	11.44 (404)	16.57 (585)	20.65 (729)	45.82 (1618)	51.88 (1832)	20.48 (723)	14.56 (514)	13.14 (464)
Standard Deviation	4.33 (153)	2.52 (89)	1.98 (70)	1.95 (69)	2.27 (80)	5.81 (205)	11.19 (395)	16.65 (589)	22.74 (803)	15.26 (539)	8.07 (285)	7.36 (260)
Flow Water Year 1975	12.23 (432)	12.38 (437)	8.44 (298)	9.71 (343)	10.79 (381)	14.47 (511)	13.39 (473)	33.76 (1,192)	73.55 (2,597)	41.32 (1,459)	13.57 (479)	11.65 (411)



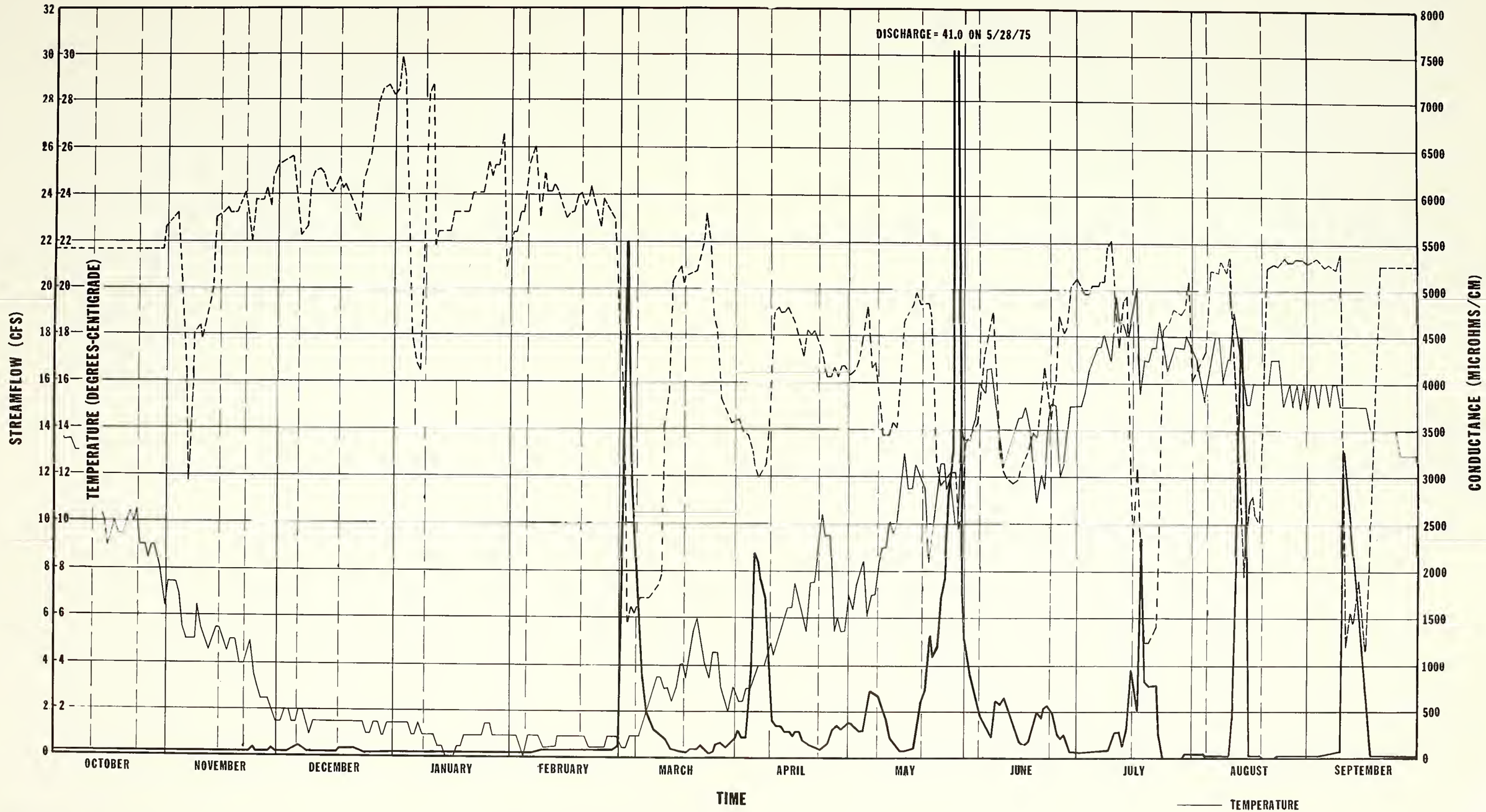
PRELIMINARY SUBJECT TO CHANGE

MEAN DAILY TEMPERATURE, STREAMFLOW AND SPECIFIC CONDUCTANCE

EVACUATION CREEK BELOW PARK CANYON NEAR WATSON, UTAH - (S-7)

OCTOBER 1974 - SEPTEMBER 1975

FIGURE II-5



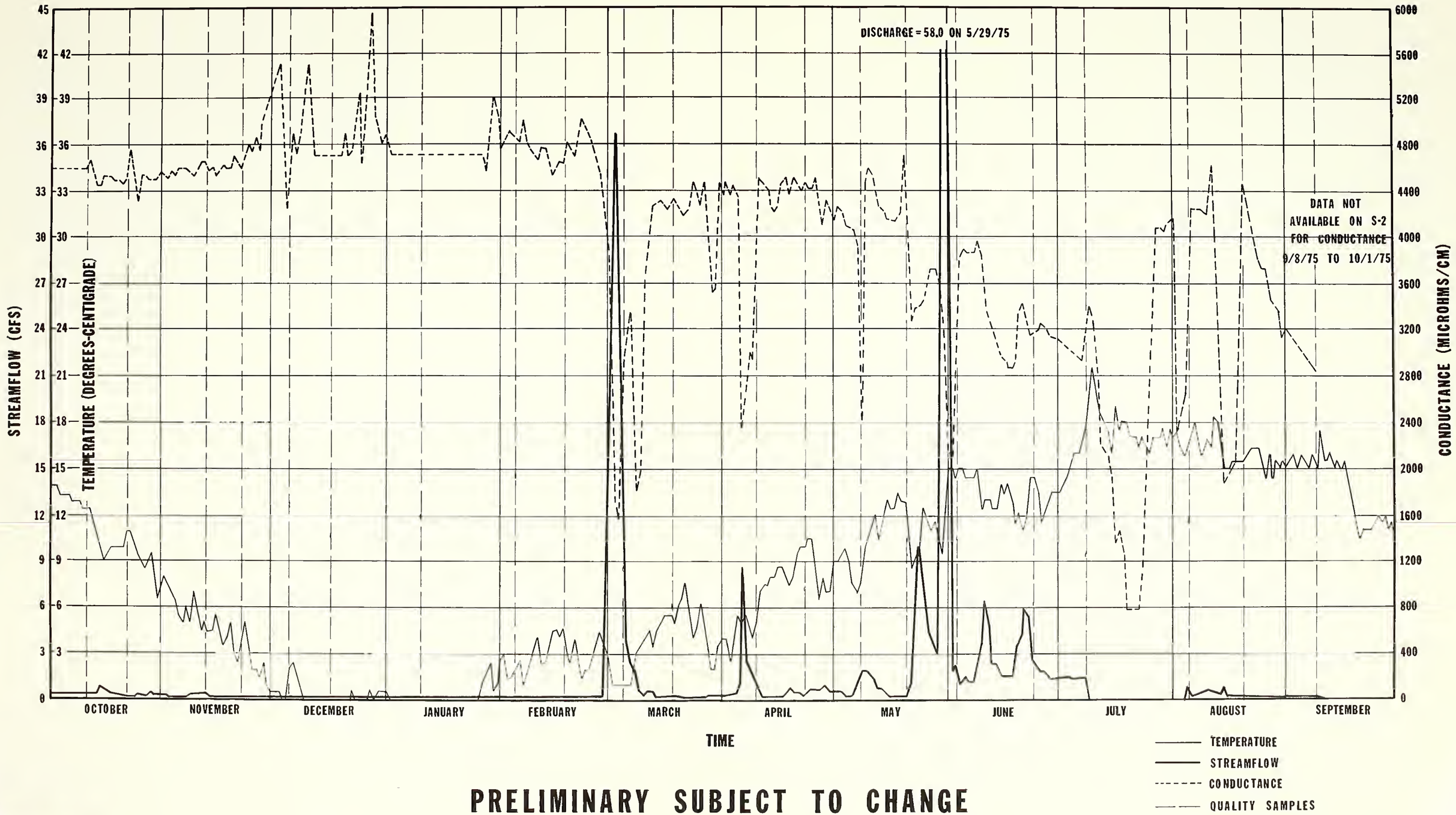
PRELIMINARY SUBJECT TO CHANGE

MEAN DAILY TEMPERATURE, STREAMFLOW AND SPECIFIC CONDUCTANCE

EVACUATION CREEK AT WATSON, UTAH - (S-6)

OCTOBER 1974 - SEPTEMBER 1975

FIGURE II-6



PRELIMINARY SUBJECT TO CHANGE

MEAN DAILY TEMPERATURE, STREAMFLOW AND SPECIFIC CONDUCTANCE

EVACUATION CREEK NEAR MOUTH BELOW WATSON, UTAH - (S-2)

OCTOBER 1974 - SEPTEMBER 1975

FIGURE II-7

c. Hells Hole Canyon, Southam Canyon, and Asphalt Wash

Table II-2 summarizes the flows recorded during the year at the mouths of Hells Hole Canyon, Southam Canyon, and Asphalt Wash. Flows are irregular and short term, as is expected for small washes in a semi-arid environment.

d. Precipitation and Evaporation

A year's record is now available for most of the precipitation gauges. Evaporation pan records from May through September are also available. Precipitation varied over the area from 21 cm (8 in.) to 29 cm (11 in.) for the year. Precipitation showed a trend of increasing by 8.1 cm (3.2 in.) for every 305 m (1,000 ft) of increase in elevation. Figure II-8 is an isohyetal plot made from the first-year data. Potential evaporation from May through September was 9.6 cm (39.2 in.) in Southam Canyon and 100.1 cm (39.4 in.) on the ridge above Evacuation Creek.

2. SURFACE WATER QUALITY

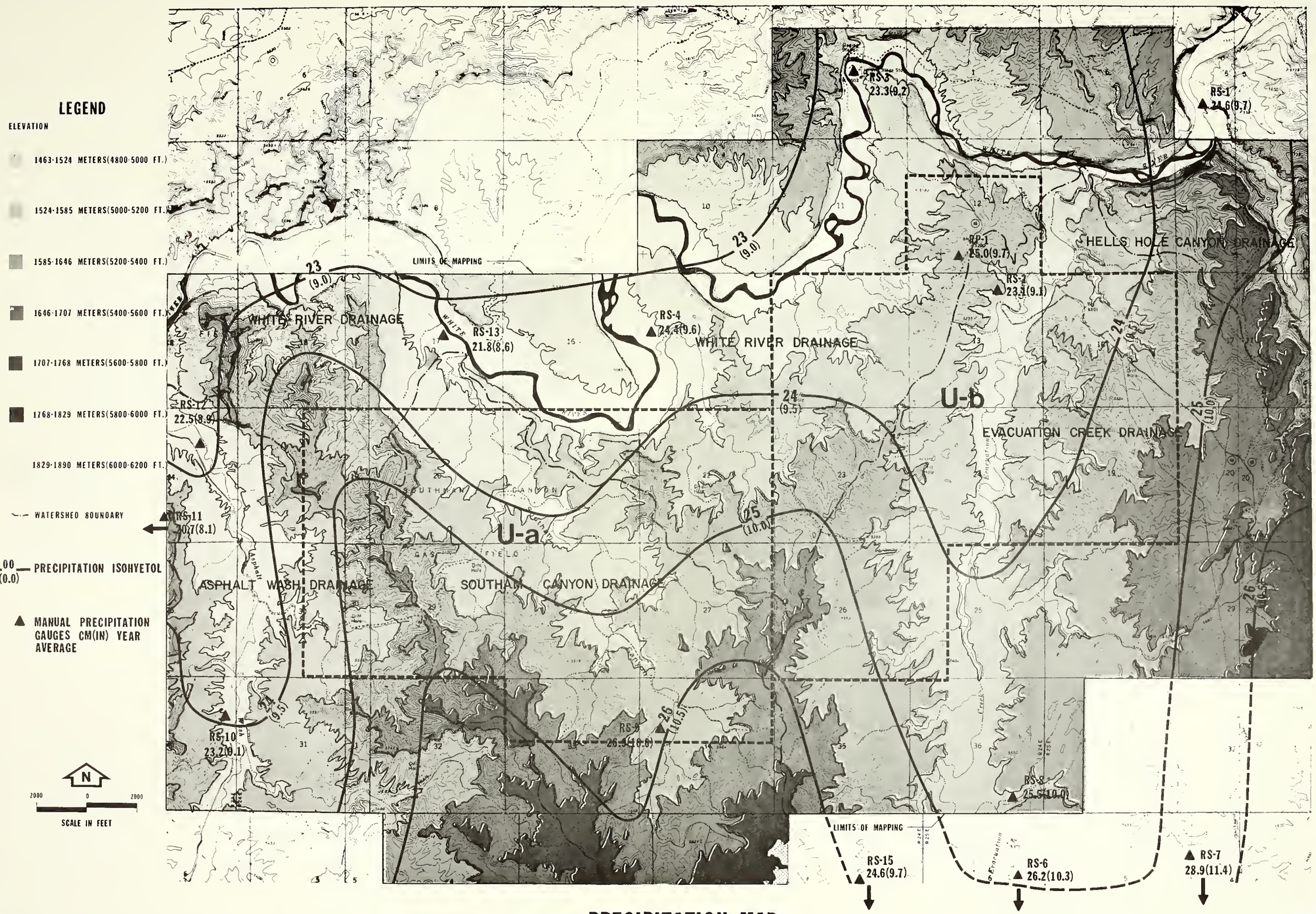
a. White River

Summaries similar to those done for the baseflow period (reported in the fourth quarterly report) were done for the water quality of the White River during the high-flow period. (See Tables II-3 through II-6.) During the runoff period, the concentration of dissolved solids was about 60 percent of the concentration during baseflow. Of the major ions, bicarbonate showed the least decrease (27 percent), and chloride showed the greatest (60 percent). As shown in Figure II-9, the ionic balances did not change substantially from those of the baseflow period. Variations among the trace elements showed the greater spread, ranging from a 60 percent decrease for zinc to a 173 percent increase for vanadium. In both periods, though, the distribution for these elements has shown high standard deviations, so differences are not as indicative as differences in the major elements. For nutrients, nitrate showed a slight decrease (8 percent), and phosporus substantially increased (150 percent). Kjeldahl nitrogen showed a 500 percent increase.

TABLE II-2

HELLS HOLE CANYON, SOUTHAM CANYON, AND ASPHALT WASH STREAMFLOW RECORDS
m^3/s (cfs)

STATION		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
S-5 Hells Hole Canyon	Number of Days of Flow	0	0	0	0	1	2	0	1	0	2	4	
	Mean Daily Flow During Event	-	-	-	-	0.195 (6.9)	0.075 (2.66)	-	0.059 (2.1)	-	0.022 (.076)	0.023 (.082)	
S-9 Southam Canyon	Number of Days of Flow	0	0	0	0	1	1	0	0	0	0	0	
	Mean Daily Flow During Event	-	-	-	-	0.014 (.49)	0.008 (.28)	-	-	-	-	-	
S-13 Southam Canyon	Number of Days of Flow	0	0	0	0	1	2	1	0	0	0	0	
	Mean Daily Flow During Event	-	-	-	-	0.134 (4.7)	0.083 (2.9)	0.001 (0.02)	-	-	-	-	
S-10 Asphalt Wash	Number of Days of Flow	0	0	0	0	2	0	0	0	0	1	1	
	Mean Daily Flow During Event	-	-	-	-	0.044 (1.56)	-	-	-	-	0.037 (1.30)	0.002 (0.06)	
S-12 Asphalt Wash	Number of Days of Flow	0	0	0	0	0	1	0	0	0	2	4	
	Mean Daily Flow During Event	-	-	-	-	-	0.007 (0.23)	-	-	-	0.070 (2.49)	0.068 (2.40)	



PRECIPITATION MAP

OCTOBER 1974 - SEPTEMBER 1975

CM (IN)

FIGURE II-8

TABLE II-3

SUMMARY OF WATER QUALITY
WHITE RIVER ABOVE HELLS HOLE CANYON (S-I)
May 6, 1975 thru August 5, 1975

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (^{o}C)	7	15.6	4.9	21.0	8.5
Turbidity (JTU)	7	454	443	1200	46
Conductance (umhos)	7	505	106	800	365
Chemical Oxygen Demand (mg/l)	7	56	50	140	13
pH (pH Units)	6	8.3	0.2	8.6	8.0
Carbon Dioxide (mg/l)	6	1.5	0.6	2.3	0.6
Alkalinity (mg/l $CACO_3$)	7	143	29	193	119
Bicarbonate (mg/l HCO_3)	7	175	35	235	145
Carbonate (mg/l CO_3)	6	0.17	0.41	1	0
Filterable Residue (mg/l)	3	347	148	510	220
Oil & Grease (mg/l)	7	2.0	3.2	9	0
Ammonia (mg/l N)*	7	0.02	0.02	0.04	0.00
Nitrite (mg/l N)*	7	0.004	0.005	0.01	0.00
Nitrate (mg/l N)*	7	0.12	0.12	0.36	0.01
Kjeldahl Nitrogen (mg/l N)	7	2.6	1.9	4.9	0.41
NO_2 + NO_3 (mg/l N)*	7	0.12	0.12	0.36	0.01
Orthophosphate (mg/l PO_4)*	7	0.06	0.03	0.09	0.03
Phosphorous (mg/l)	7	0.25	0.15	0.46	0.01
Orthophosphorous (mg/l P)*	7	0.02	0.01	0.03	0.01
Total Organic Carbon (mg/l)	1	39	-	39	-
Total Inorganic Carbon (mg/l)	-	-	-	-	-
Cyanide (mg/l)	4	0	0	0	-
Sulfide (mg/l)*	7	0.06	0.05	0.1	0.0
Hardness (mg/l Ca, Mg)	7	194	52	270	150
Non Carbonate Hardness (mg/l)	7	52	24	91	29
Calcium (mg/l)*	7	49	11	63	38
Magnesium (mg/l)*	7	18	6	27	13
Sodium (mg/l)*	7	35	18	66	21
Sodium Adsorption Ratio	7	1.1	0.4	1.8	0.7
% Sodium	7	27	5	35	21
Potassium (mg/l)*	7	1.7	0.3	2.0	1.3
Chloride (mg/l)*	7	17	11	37.0	8.3
Sulfate (mg/l)*	7	98	44	170	59
Fluoride (mg/l)*	7	0.21	0.04	0.3	0.2
Bromide (mg/l)	7	0.0	0.0	0.1	0.0
Silica (mg/l)*	7	13	1.3	15	11
Arsenic (mg/l)*	4	0.001	0.0008	0.002	0.000
Barium (mg/l)*	5	0.074	0.069	0.140	0.000
Beryllium (mg/l)*	3	<0.00033	-	<0.001	-
Bismuth (mg/l)*	2	<0.004	-	<0.006	-
Boron (mg/l)*	5	0.043	0.011	0.060	0.030
Cadmium (mg/l)*	5	<0.0008	-	<0.004	-
Chromium (mg/l)*	5	<0.002	0.0035	0.008	0.000
Cobalt (mg/l)*	5	<0.001	0.001	0.002	0.000
Copper (mg/l)*	5	0.0034	0.0019	0.006	0.002
Iron (mg/l)*	5	-	0.032	0.060	0.00
Lead (mg/l)*	5	<0.0014	0.0017	0.004	0.000
Manganese (mg/l)*	5	0.019	0.035	0.082	0.00
Mercury (mg/l)*	4	0.00003	0.0005	0.0001	0.0000
Molybdenum (mg/l)*	5	0.0032	0.0019	0.006	0.001
Nickel (mg/l)*	5	0.0042	0.0048	0.012	0.000
Silver (mg/l)*	3	0.000	-	0.000	0.000
Strontium (mg/l)*	3	0.493	0.162	0.680	0.390
Vanadium (mg/l)*	5	0.0032	0.0063	0.010	0.0008
Zinc (mg/l)*	5	0.012	0.011	0.030	0.000
Tin (mg/l)*	2	<0.004	-	<0.006	-
Aluminum (mg/l)*	5	<1.224	2.67	6.00	<0.010
Gallium (mg/l)*	2	<0.001	-	<0.002	-
Germanium (mg/l)*	2	<0.003	-	<0.004	<0.002
Lithium (mg/l)*	5	0.009	0.0010	0.0020	0.00
Selenium (mg/l)*	4	0.0013	0.0005	0.002	0.001
Titanium (mg/l)*	2	0.304	0.419	0.600	0.007
Zirconium (mg/l)*	2	0.0017	0.0019	0.030	<0.003
Gross Beta (pc/l Cs_{137})*	3	4.8	1.9	6.9	3.4
Chlorophyll A (mg/l)	3	0.0057	0.0064	0.013	0.0009
Chlorophyll B (mg/l)	3	0.0019	0.0005	0.0023	0.0013
Phenols (mg/l)	7	0.0044	0.0021	0.009	0.002
Dissolved Solids (mg/l)*	7	324	107	484	226
Gross Alpha (mg/l U)*	3	0.0069	0.0027	0.0085	0.0027
Gross Beta (pc/l SR_{90}/Y_{90})*	3	3.8	1.6	5.6	2.7

*Elements analyzed only for dissolved fraction

TABLE II-4

SUMMARY OF WATER QUALITY
WHITE RIVER NEAR WATSON UTAH (S-3)
May 5, 1975 thru August 4, 1975

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (°C)	7	16.3	4.6	22.0	10.5
Turbidity (JTU)	6	389	283	800	76
Conductance (umhos)	7	533	165	760	330
Chemical Oxygen Demand (mg/1)	6	40	23	81	19
pH (pH Units)	7	8.4	0.8	10.1	7.4
Carbon Dioxide (mg/1)	7	2.8	3.4	10	0.0
Alkalinity (mg/1 $CACO_3$)	7	145	31	196	107
Bicarbonate (mg/1 HCO_3)	7	154	77	239	131
Carbonate (mg/1 CO_3)	7	0	-	0	0
Filterable Residue (mg/1)	3	360	115	490	270
Oil & Grease (mg/1)	6	1.3	0.5	2	1
Ammonia (mg/1 N)*	6	0.03	0.05	0.13	0.00
Nitrite (mg/1 N)*	6	0.002	0.004	0.01	0.00
Nitrate (mg/1 N)*	6	0.11	0.12	0.33	0.01
Kjeldahl Nitrogen (mg/1 N)	6	1.9	1.1	3.3	0.86
NO_2 + NO_3 (mg/1 N)*	7	0.10	0.11	0.33	0.01
Orthophosphate (mg/1 PO_4)*	7	30	79	210	0.00
Phosphorous (mg/1)	6	0.38	0.41	1.1	0.01
Orthophosphorous (mg/1 P)*	7	9.7	26	68	0.01
Total Organic Carbon (mg/1)	1	14	-	14	-
Total Inorganic Carbon (mg/1)	0	-	-	-	-
Cyanide (mg/1)	3	0.00	0.00	0.00	0.00
Sulfide (mg/1)*	5	0.06	0.05	0.1	0.0
Hardness (mg/1 Ca, Mg)	7	200	51	270	140
Non Carbonate Hardness (mg/1)	7	55	24	97	29
Calcium (mg/1)*	7	50	12	67	35
Magnesium (mg/1)*	7	18	6	27	12
Sodium (mg/1)*	7	35	18	60	17
Sodium Adsorption Ratio	7	1.0	0.4	1.7	0.6
% Sodium	7	26	5	34	18
Potassium (mg/1)*	7	1.7	0.4	2.2	1.2
Chloride (mg/1)*	7	17	9.6	35	8.9
Sulfate (mg/1)*	7	100	46	180	59
Fluoride (mg/1)*	7	0.21	0.04	0.3	0.2
Bromide (mg/1)	5	0.0	0.1	0.4	0.0
Silica (mg/1)*	7	11	4.7	15	1.0
Arsenic (mg/1)*	3	0.0010	0.0010	.002	0.001
Barium (mg/1)*	4	0.058	0.068	.130	0.000
Beryllium (mg/1)*	2	0.000	-	0.000	-
Bismuth (mg/1)*	1	0.002	-	<0.002	-
Boron (mg/1)*	5	0.051	0.025	0.090	0.025
Cadmium (mg/1)*	4	0.0008	-	<0.003	-
Chromium (mg/1)*	4	0.0005	-	<0.002	-
Cobalt (mg/1)*	4	<0.00075	-	<0.002	-
Copper (mg/1)*	4	0.0025	0.0022	0.005	0.001
Iron (mg/1)*	4	0.040	0.023	0.060	0.020
Lead (mg/1)*	4	<0.0005	0.0010	<0.002	0.000
Manganese (mg/1)*	4	0.0010	0.0020	0.004	0.00
Mercury (mg/1)*	3	0.000	0.0000	0.0000	0.0000
Molybdenum (mg/1)*	4	0.0023	0.0010	0.003	0.001
Nickel (mg/1)*	4	0.0033	0.0017	0.005	0.001
Silver (mg/1)*	2	0.000	0.000	0.000	0.000
Strontium (mg/1)*	2	0.210	0.212	0.360	0.060
Vanadium (mg/1)*	4	0.0016	0.0009	0.0025	0.0004
Zinc (mg/1)*	4	0.0093	0.011	0.020	0.00
Tin (mg/1)*	1	<0.002	-	<0.002	-
Aluminum (mg/1)*	4	0.040	0.034	0.090	0.020
Gallium (mg/1)*	1	0	-	0	-
Germanium (mg/1)*	1	<0.002	-	<0.002	-
Lithium (mg/1)*	4	0.0063	0.0095	0.020	0.00
Selenium (mg/1)*	3	0.0007	0.0006	0.001	0.000
Titanium (mg/1)*	1	0.006	-	0.006	-
Zirconium (mg/1)*	1	<0.003	-	<0.003	-
Gross Beta (pc/1 Cs_{137})*	3	4.8	1.1	6.0	4.1
Chlorophyll A (mg/1)	3	0.0030	0.0021	0.0054	0.0018
Chlorophyll B (mg/1)	3	0.0026	0.0012	0.0035	0.0012
Phenols (mg/1)	5	0.0048	0.0008	0.006	0.004
Dissolved Solids (mg/1)*	6	310	90	462	223
Gross Alpha (mg/1 U)*	3	<0.0078	0.0030	0.010	<0.0043
Gross Beta (pc/1 SR_{90}/Y_{90})*	3	3.8	0.9	4.9	3.2

*Elements analyzed only for dissolved fraction

TABLE II-5

SUMMARY OF WATER QUALITY
WHITE RIVER ABOVE SOUTHAM CANYON (S-4)
May 6, 1975 thru August 6, 1975

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (^{o}C)	7	15.8	5.5	22.0	7.9
Turbidity (JTU)	7	896	880	2000	60
Conductance (umhos)	7	506	174	810	360
Chemical Oxygen Demand (mg/1)	7	80	71	200	17
pH (pH Units)	6	8.1	0.5	8.8	7.2
Carbon Dioxide (mg/1)	6	4.3	6.2	17	0.4
Alkalinity (mg/1 $CACO_3$)	7	145	27	193	126
Bicarbonate (mg/1 HCO_3)	7	176	33	235	153
Carbonate (mg/1 CO_3)	7	0	0	0	0
Filterable Residue (mg/1)	4	418	131	560	270
Oil & Grease (mg/1)	7	2.1	1.6	5	0
Ammonia (mg/1 N)*	7	0.026	0.022	0.06	0.00
Nitrite (mg/1 N)*	7	0.013	0.011	0.03	0.00
Nitrate (mg/1 N)*	7	0.12	0.11	0.32	0.01
Kjeldahl Nitrogen (mg/1 N)	7	2.6	2.6	7.6	0.47
NO_2 + NO_3 (mg/1 N)*	7	0.14	0.10	0.32	0.01
Orthophosphate (mg/1 PO_4)*	7	0.07	0.06	0.18	0.00
Phosphorous (mg/1)	7	0.98	0.68	1.9	0.19
Orthophosphorous (mg/1 P)*	7	0.022	0.021	0.06	0.00
Total Organic Carbon (mg/1)	1	48	-	48	-
Total Inorganic Carbon (mg/1)	0	-	-	-	-
Cyanide (mg/1)	4	0.003	0.005	0.01	0.00
Sulfide (mg/1)*	7	0.07	0.10	0.2	0.0
Hardness (mg/1 Ca, Mg)	7	199	49	280	160
Non Carbonate Hardness (mg/1)	7	52	25	100	26
Calcium (mg/1)*	7	49	11	64	40
Magnesium (mg/1)*	7	18	5	28	14
Sodium (mg/1)*	7	40	19	75	21
Sodium Adsorption Ratio	7	1.2	0.4	2.0	0.7
% Sodium	7	29	5	37	21
Potassium (mg/1)*	7	1.9	0.4	2.4	1.3
Chloride (mg/1)*	7	18	12	42	8.6
Sulfate (mg/1)*	7	106	46	190	66
Fluoride (mg/1)*	7	0.24	0.05	0.3	0.2
Bromide (mg/1)	7	0.0	0.1	0.1	0.0
Silica (mg/1)*	7	13	2	17	11
Arsenic (mg/1)*	4	0.001	.0008	0.002	0.000
Barium (mg/1)*	5	0.053	.050	0.1	0.0
Beryllium (mg/1)*	2	0	0	0	0.000
Bismuth (mg/1)*	1	0.002	-	0.002	-
Boron (mg/1)*	5	0.056	.023	0.090	.040
Cadmium (mg/1)*	5	<0.0012	-	<0.004	-
Chromium (mg/1)*	5	<0.0004	-	<0.002	-
Cobalt (mg/1)*	5	<0.0006	-	<0.002	-
Copper (mg/1)*	5	0.0054	0.0035	0.011	0.002
Iron (mg/1)*	5	0.062	0.048	0.13	0.01
Lead (mg/1)*	5	<0.0022	0.0022	0.005	0.000
Manganese (mg/1)*	5	0.0016	0.0023	0.005	0.00
Mercury (mg/1)*	4	0.00005	0.0001	0.0002	0.0000
Molybdenum (mg/1)*	5	0.0026	0.0013	0.004	0.001
Nickel (mg/1)*	5	0.0038	0.0023	0.006	0.001
Silver (mg/1)*	2	0.000	0.000	0.000	0.000
Strontium (mg/1)*	2	0.505	0.120	0.590	0.420
Vanadium (mg/1)*	5	0.0019	0.0009	0.0030	0.0004
Zinc (mg/1)*	5	0.0074	0.0083	0.020	0
Tin (mg/1)*	1	<0.002	-	<0.002	-
Aluminum (mg/1)*	5	0.072	0.075	0.200	0.020
Gallium (mg/1)*	1	0	-	0	-
Germanium (mg/1)*	1	<0.002	-	<0.002	-
Lithium (mg/1)*	5	0.0054	0.0087	0.020	0.000
Selenium (mg/1)*	4	0.0006	0.0009	0.002	0.000
Titanium (mg/1)*	1	0.010	-	0.010	-
Zirconium (mg/1)*	1	<0.003	-	<0.003	-
Gross Beta (pc/1 Cs_{137})*	4	3.5	0.5	4.1	2.8
Chlorophyll A (mg/1)	2	0.0095	0.0022	0.011	0.0079
Chlorophyll B (mg/1)	2	0.0076	0.0025	0.011	0.0079
Phenols (mg/1)	7	0.006	0.0041	0.014	0.002
Dissolved Solids (mg/1)*	7	342	114	536	245
Gross Alpha (mg/1 U)*	4	<0.0065	0.0039	0.012	<0.0038
Gross Beta (pc/1 SR_{90}/Y_{90})*	4	2.9	0.5	3.4	2.3

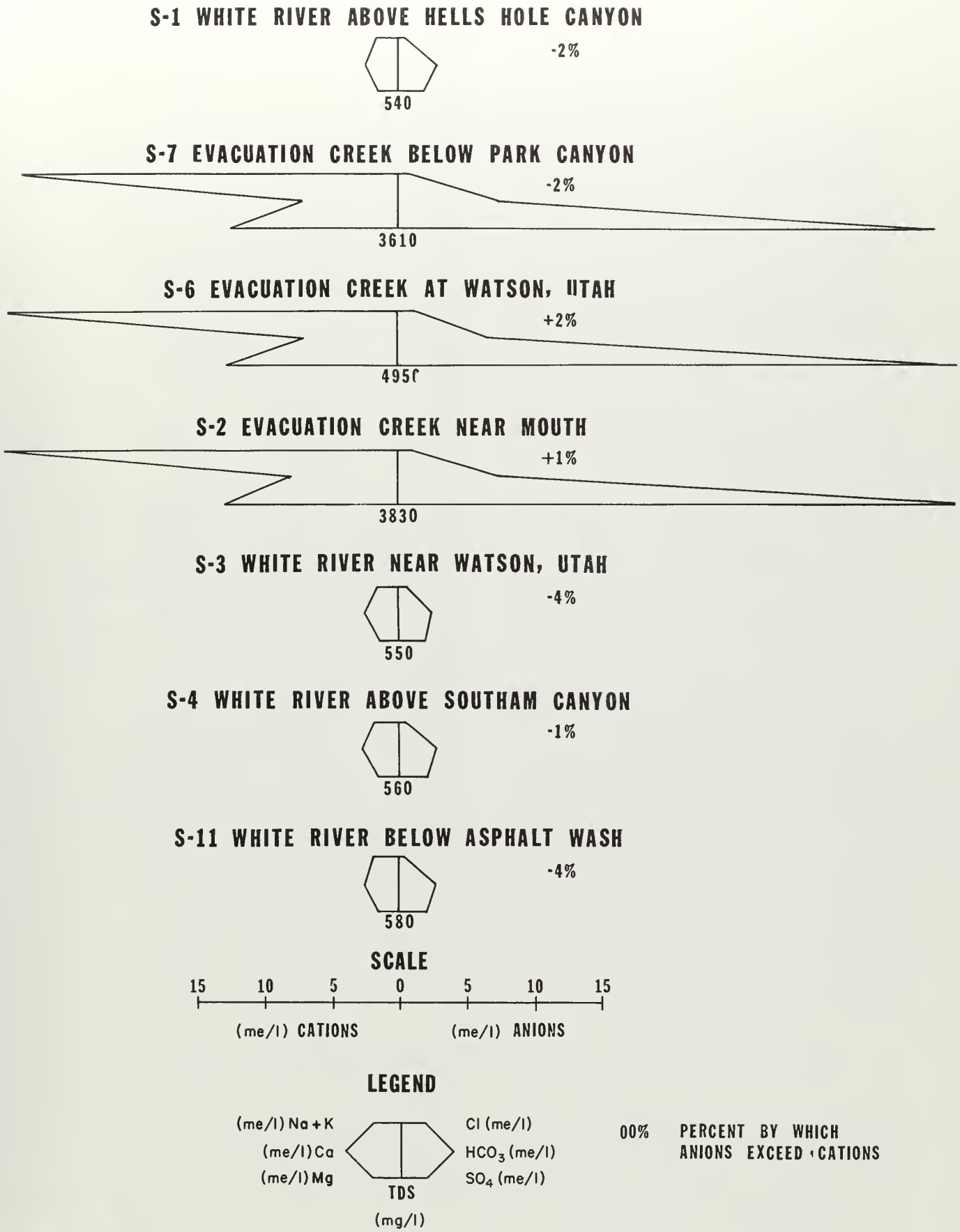
*Elements analyzed only for dissolved fraction

TABLE II-6

SUMMARY OF WATER QUALITY
WHITE RIVER BELOW ASPHALT WASH (S-11)
May 15, 1975 thru August 7, 1975

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (^{o}C)	7	17.1	3.9	21.0	10.1
Turbidity (JTU)	6	323	269	760	56
Conductance (umhos)	6	480	157	710	320
Chemical Oxygen Demand (mg/l)	6	23	11	40	8
pH (pH Units)	4	7.9	0.3	8.3	7.6
Carbon Dioxide (mg/l)	4	4.1	2.8	8.2	1.9
Alkalinity (mg/l $CACO_3$)	6	141	32	191	123
Bicarbonate (mg/l HCO_3)	6	172	39	233	125
Carbonate (mg/l CO_3)	6	0	0	0	0
Filterable Residue (mg/l)	2	360	127	450	270
Oil & Grease (mg/l)	6	1.7	1.8	5	0
Ammonia (mg/l N)*	6	0.011	0.015	0.03	0.00
Nitrite (mg/l N)*	6	0.010	0.011	0.03	0.00
Nitrate (mg/l N)*	6	0.14	0.13	0.38	0.01
Kjeldahl Nitrogen (mg/l N)	6	1.2	0.8	2.5	0.45
NO_2 + NO_3 (mg/l N)*	6	0.15	0.13	0.39	0.02
Orthophosphate (mg/l PO_4)*	6	0.04	0.04	0.12	0.00
Phosphorous (mg/l)	6	0.29	0.21	0.61	0.05
Orthophosphorous (mg/l P)*	6	0.013	0.014	0.04	0.00
Total Organic Carbon (mg/l)	1	8.8	-	8.8	-
Total Inorganic Carbon (mg/l)	0	-	-	-	-
Cyanide (mg/l)	4	0.003	0.005	0.01	0.00
Sulfide (mg/l)*	6	0.07	0.08	0.2	0.0
Hardness (mg/l Ca, Mg)	6	192	49	270	140
Non Carbonate Hardness (mg/l)	6	50	34	77	31
Calcium (mg/l)*	6	48	11	66	41
Magnesium (mg/l)*	6	17	5	25	11
Sodium (mg/l)*	6	35	14	55	22
Sodium Adsorption Ratio	6	1.1	0.3	1.5	0.8
% Sodium	6	28	3	32	24
Potassium (mg/l)*	6	1.8	0.4	2.3	1.3
Chloride (mg/l)*	6	15	8	27	9.3
Sulfate (mg/l)*	6	101	34	150	63
Fluoride (mg/l)*	6	0.22	0.04	0.3	0.2
Bromide (mg/l)	7	0.0	0.1	0.1	0.0
Silica (mg/l)*	6	13	2	15	11
Arsenic (mg/l)*	4	0.0015	0.001	0.002	0.000
Barium (mg/l)*	4	<0.025	-	<0.100	-
Beryllium (mg/l)*	1	0.000	-	0.000	-
Bismuth (mg/l)*	0	-	-	-	-
Boron (mg/l)*	4	0.053	0.025	0.080	0.020
Cadmium (mg/l)*	4	0.0005	0.001	0.002	0.000
Chromium (mg/l)*	4	0.0025	0.005	0.010	0.000
Cobalt (mg/l)*	4	0.00025	0.0005	0.001	0.000
Copper (mg/l)*	4	0.0055	0.0051	0.013	0.002
Iron (mg/l)*	4	0.045	0.021	0.07	0.02
Lead (mg/l)*	4	0.0013	0.0015	0.003	0.000
Manganese (mg/l)*	4	0.0025	0.005	0.01	0.00
Mercury (mg/l)*	4	0.0000	0.0000	0.0000	0.0000
Molybdenum (mg/l)*	4	0.0020	0.0008	0.003	0.001
Nickel (mg/l)*	4	0.0035	0.0021	0.006	0.006
Silver (mg/l)*	1	0.000	-	0.000	-
Strontium (mg/l)*	1	0.060	-	0.060	-
Vanadium (mg/l)*	4	0.001	0.0011	0.0024	0.0000
Zinc (mg/l)*	4	0.0015	0.003	0.006	0.000
Tin (mg/l)*	0	-	-	-	-
Aluminum (mg/l)*	4	0.035	0.010	0.050	0.030
Gallium (mg/l)*	0	-	-	-	-
Germanium (mg/l)*	0	-	-	-	-
Lithium (mg/l)*	4	0.0075	0.0096	0.020	0.000
Selenium (mg/l)*	4	0.0008	0.0005	0.001	0.000
Titanium (mg/l)*	0	-	-	-	-
Zirconium (mg/l)*	0	-	-	-	-
Gross Beta (pc/l Cs_{137})*	2	3.85	0.07	3.9	3.8
Chlorophyll A (mg/l)	4	0.0059	0.0051	0.013	0.002
Chlorophyll B (mg/l)	4	0.0053	0.0043	0.0099	0.0002
Phenols (mg/l)	6	0.0043	0.0042	0.007	0.002
Dissolved Solids (mg/l)*	6	326	93	467	223
Gross Alpha (mg/l U)*	2	0.0064	0.0037	0.0090	0.0038
Gross Beta (pc/l SR_{90}/Y_{90})*	2	3.3	0.1	3.4	3.2

*Elements analyzed only for dissolved fraction



BALANCE AND DISTRIBUTION OF MAJOR IONS IN SURFACE WATER
HIGH FLOW PERIOD MAY, 1975 - JULY, 1975

FIGURE II-9

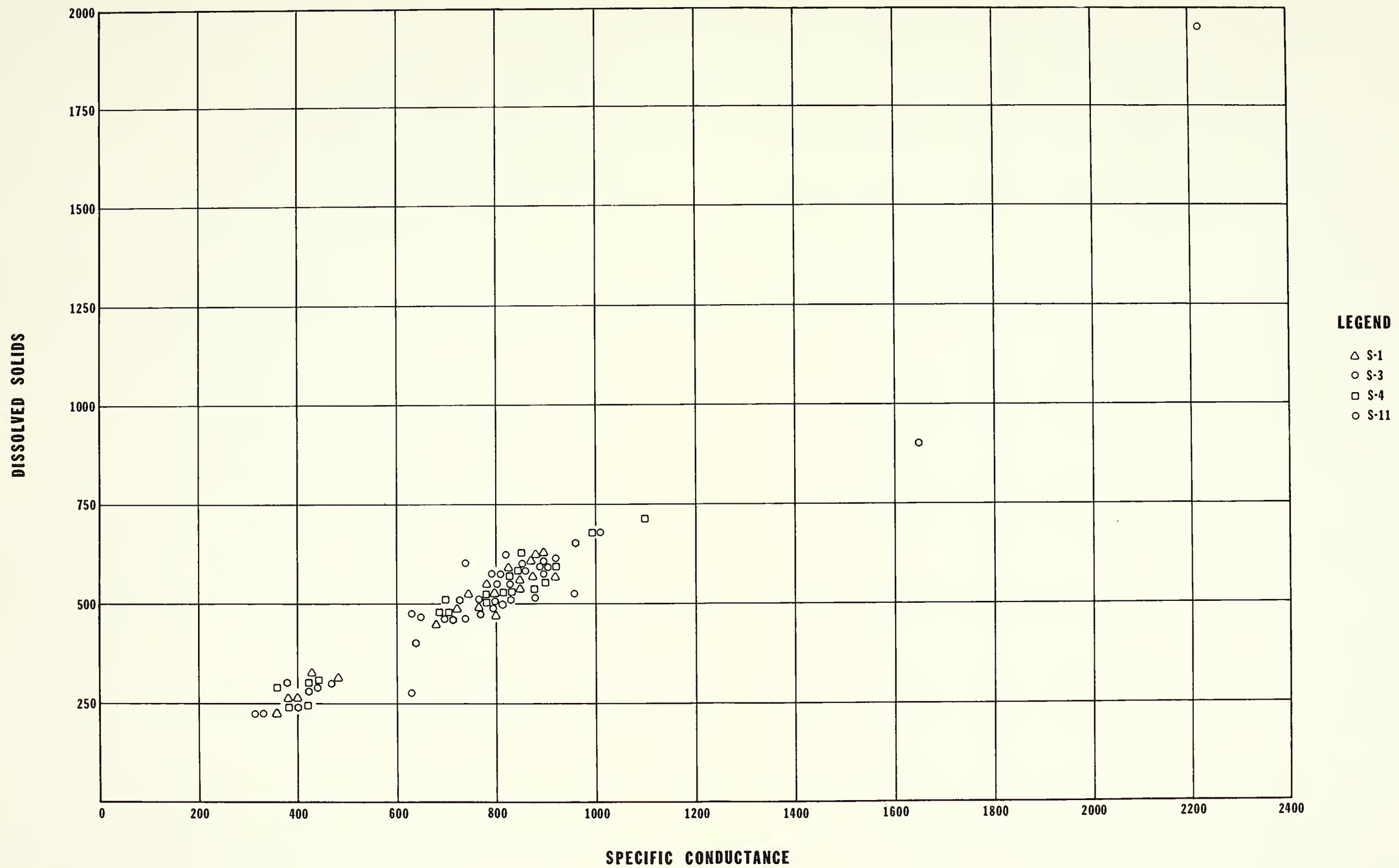
The relationship between dissolved solids and specific conductance during high flow was similar to the relationship found in the baseflow period. (On Figure II-10 the points near the origin are the high-flow points.) Dissolved oxygen levels remained near saturation at high flow (Figure II-11), although dissolved oxygen levels decreased, reflecting higher water temperatures. Coliform values varied during the year but did not reach unusually high values (Table II-7). Biochemical oxygen demand tests conducted during August, September, and October ranged from 0.3 mg/l to 1.4 mg/l. These values are low and are typical of streams that receive little domestic wastewater.

b. Evacuation Creek

Summaries of water quality for the three Evacuation Creek stations during the high-flow period are shown in Tables II-8 through II-10. As in the White River, most element concentrations show decreases during high-flow and increases during baseflow. Dissolved solids are about 70 percent of the baseflow concentration, with the major ions showing decreases ranging from 26 percent for magnesium to 41 percent for chloride. Trace element changes range from a 52 percent decrease in boron to a 200 percent increase in iron. Both nitrate and phosporus increased (165 and 1,400 percent, respectively). The ionic balances, though, show the same relation they did during the baseflow period (Figure II-9). The dissolved solids-specific conductance relation also followed the trend established in the baseflow period (Figure II-12). Dissolved oxygen values were near or above saturation in all but a few cases (Figure II-11). Pesticides and pathogens were absent in all samples analysed for them during the year. Coliforms showed wide variation during the year. This is probably related to the movements of grazing stock in the tract area. Biochemical oxygen demand tests conducted in August, September, and October varied between 0.8 mg/l and 1.8 mg/l.

c. Hells Hole Canyon, Asphalt Wash, and Southam Canyon

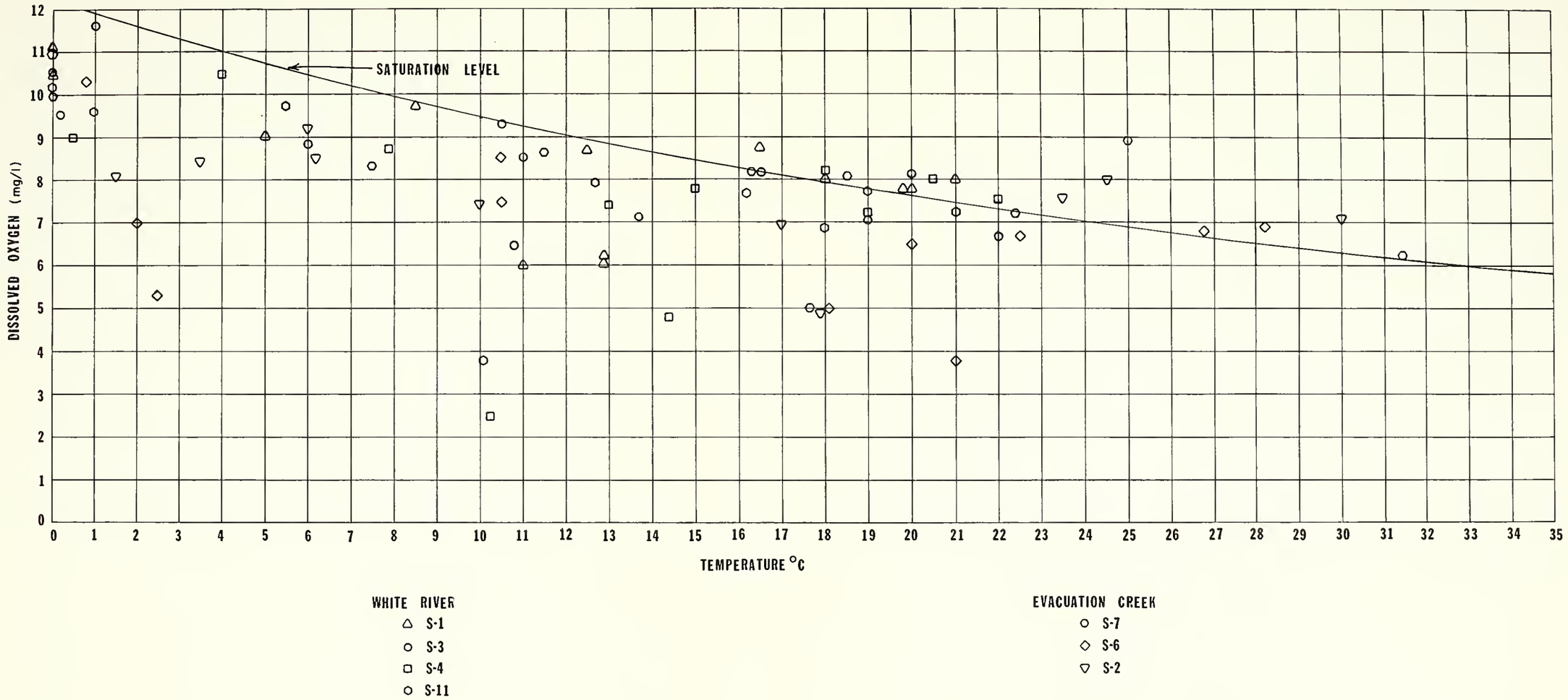
Water quality sample results for Hells Hole Canyon and Asphalt Wash are shown in Table II-11. Unfortunately, no samples could be collected from Southam Canyon. Hells Hole Canyon water shows characteristics similar to those of Evacuation Creek water; that is, the dissolved elements are dominated by calcium, sodium, and sulfate. The Asphalt Wash sample represents better quality water, with calcium,



RELATION BETWEEN SPECIFIC CONDUCTANCE AND DISSOLVED SOLIDS

WHITE RIVER
AUGUST, 1974 - SEPTEMBER, 1975

FIGURE II-10



RELATION BETWEEN TEMPERATURE AND DISSOLVED OXYGEN

AUGUST, 1974 - SEPTEMBER, 1975

FIGURE II-11

TABLE II-7

MONTHLY COLIFORM DATA

Date	Station	Total	Fecal	Fecal Strep	FC/FS Ratio
Jan 24 1975	S-1	64	50	34	1.5
	S-3	64	50	17	2.9
	S-4	26	34	17	2.0
	S-11	40	23	23	1.0
Feb 13-14	S-1	114	20	17	1.2
	S-2	0	0	1	---
	S-3	175	16	32	0.5
	S-4	104	22	20	0.1
	S-6	0	0	25	0.05±
	S-11	134	21	37	0.6
Mar 12-13	S-1	320	65	144	0.4
	S-2	0	0	16	0.06
	S-3	180	26	163	0.2
	S-4	250	30	180	0.2
	S-6	0	0	20	0.05±
	S-7	0	14	112	0.1
	S-11	240	49	142	0.3
Apr 15-16	S-1	24	4	11	0.4
	S-2	48	31	37	0.8
	S-3	12	7	8	0.9
	S-4	40	4	10	0.4
	S-6	0	6	21	0.3
	S-7	20	48	82	0.6
	S-11	80	2	4	0.5
May 13-14	S-1	280	120	22*	5.4*
	S-2	12	9	19	0.5
	S-3	380	220	203	1.1
	S-4	530	230	233	1.0
	S-6	0	0	32	---
	S-7	9	6	24	0.2
	S-11	440	250	253	1.0

*Questionable values due to heavy silt in sample

TABLE II-7 (Cont.)

Date	Station	Total	Fecal	Fecal Strep	FC/FS Ratio
June 23-24	S-1	170	12	172	0.1
	S-2	1070	4	305	0.01
	S-3	140	16	120	0.1
	S-4	100	66	110	0.6
	S-6	1250	1	173	0.01
	S-7	600	10	326	0.03
	S-11	120	24	144	0.2
July 13-14	S-1	230	80	360	0.2
	S-2	1400	6620	3680	1.8
	S-3	230	96	270	0.4
	S-4	320	124	300	0.4
	S-6	1720	1860	1580	1.2
	S-7	1360	1900	2880	0.7
	S-11	380	316	680	0.5
Aug 11-12	S-1	58	81	25*	3.2*
	S-2	1185	1440	2580	0.6
	S-3	60	102	163	0.6
	S-4	0	68	77	0.9
	S-6	950	1620	2630	0.6
	S-7	865	670	1370	0.5
	S-11	0	35	59	0.6
Sept 8-9 1/	S-1	0	0	4	---
	S-2	0	2	149	.01
	S-3	0	0	10	---
	S-4	0	3	17	0.2
	S-6	0	2	44	.05
	S-11	0	6	22	0.3
Oct 13-14 1/	S-1	1	23	42	0.6
	S-2	18	12	119	0.1
	S-3	3	5	12	0.4
	S-4	2	16	34	0.5
	S-6	6	5	200	0.03
	S-7	7	6	364	0.02
	S-11	1	20	51	0.4

*Questionable values due to heavy silt in sample

1/Questionable data - under review

TABLE II-8

SUMMARY OF WATER QUALITY
EVACUATION CREEK BELOW PARK CANYON (S-7)
March 5, 1975 thru August 6, 1975

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (°C)	10	15.1	9.9	31.4	0.0
Turbidity (JTU)	10	1123	1341	3600	12
Conductance (umhos)	10	3877	544	2900	4540
Chemical Oxygen Demand (mg/l)	10	61	77	270	13
pH (pH Units)	8	8.3	0.2	8.7	8.1
Carbon Dioxide (mg/l)	8	3.9	1.6	6.0	1.5
Alkalinity (mg/l $CACO_3$)	10	375	16	390	346
Bicarbonate (mg/l HCO_3)	10	457	19	475	422
Carbonate (mg/l CO_3)	10	0	0	0	0
Filterable Residue (mg/l)	6	3883	1063	5600	3000
Oil & Grease (mg/l)	10	1.9	1.4	5	0
Ammonia (mg/l N)*	10	0.02	0.01	0.04	0.00
Nitrite (mg/l N)*	10	0.014	0.010	0.03	0.00
Nitrate (mg/l N)*	10	1.9	1.7	5.0	0.70
Kjeldahl Nitrogen (mg/l N)	10	4.1	7.5	25	0.47
NO_2 + NO_3 (mg/l N)*	10	1.9	1.7	5.0	0.20
Orthophosphate (mg/l PO_4)*	10	0.05	0.03	0.12	0.00
Phosphorous (mg/l)	10	0.85	1.4	4.8	0.00
Orthophosphorous (mg/l P)*	10	0.017	0.012	0.04	0.00
Total Organic Carbon (mg/l)	2	4.8	3.0	6.9	2.6
Total Inorganic Carbon (mg/l)	0	-	-	-	-
Cyanide (mg/l)	6	0.002	0.004	0.01	0.00
Sulfide (mg/l)*	10	0.005	0.007	0.2	0.0
Hardness (mg/l Ca, Mg)	10	963	118	1100	730
Non Carbonate Hardness (mg/l)	10	589	120	750	380
Calcium (mg/l)*	10	137	18	160	120
Magnesium (mg/l)*	10	151	20	180	110
Sodium (mg/l)*	10	658	83	790	490
Sodium Adsorption Ratio	10	9.2	0.7	10.0	7.9
% Sodium	10	60	1.7	62	56
Potassium (mg/l)*	10	6.5	1.6	8.8	4.9
Chloride (mg/l)*	10	31	6	43	23
Sulfate (mg/l)*	10	1920	282	2400	1400
Fluoride (mg/l)*	10	0.66	0.16	0.9	0.4
Bromide (mg/l)	9	0.2	0.1	0.5	0.2
Silica (mg/l)*	10	11	2	15	9.5
Arsenic (mg/l)*	6	0.0012	0.0008	0.002	0.0
Barium (mg/l)*	7	<0.123	0.140	0.400	0.0
Beryllium (mg/l)*	3	0.005	0.005	0.010	0.0
Bismuth (mg/l)*	1	<0.015	-	<0.015	-
Boron (mg/l)*	7	0.482	0.304	1.100	0.220
Cadmium (mg/l)*	7	0.000	0.000	0.000	0.000
Chromium (mg/l)*	7	<0.0021	-	<0.0015	-
Cobalt (mg/l)*	7		-		
Copper (mg/l)*	7	<0.0024		<0.0015	-
Iron (mg/l)*	7	0.0054	0.0029	0.010	0.003
Lead (mg/l)*	7	0.050	0.043	0.120	0.01
Manganese (mg/l)*	7	0.0026	0.0055	0.015	0.000
Mercury (mg/l)*	6	0.030	0.016	0.06	0.01
Molybdenum (mg/l)*	7	0.000017	0.00004	0.0001	0.0000
Nickel (mg/l)*	7	<0.024	0.010	0.042	0.013
Silver (mg/l)*	3	<0.0047	-	<0.015	-
Strontium (mg/l)*	3	<0.001	-	<0.002	-
Vanadium (mg/l)*	7	3.366	0.306	3.700	3.100
Zinc (mg/l)*	7	<0.0026	-	<0.015	-
Tin (mg/l)*	1	0.0089	0.010	0.020	0.00
Aluminum (mg/l)*	7	<0.015	-	<0.015	-
Gallium (mg/l)*	1	0.040	0.042	0.130	0.010
Germanium (mg/l)*	1	<0.007	-	<0.007	-
Lithium (mg/l)*	7	<0.020	-	<0.020	-
Selenium (mg/l)*	6	0.067	0.015	0.090	0.050
Titanium (mg/l)*	1	0.0025	0.001	0.004	0.001
Zirconium (mg/l)*	1	<0.015	-	<0.015	-
Gross Beta (pc/l Cs_{137})*	6	≤0.030	-	<0.030	-
Chlorophyll A (mg/l)	4	6	4.9	30	<17
Chlorophyll B (mg/l)	4	0.0024	0.0021	5.2	0.8
Phenols (mg/l)	10	0.0016	0.0017	0.0039	0.0000
Dissolved Solids (mg/l)*	10	0.0070	0.0043	0.014	0.001
Gross Alpha (mg/l U)*	6	3260	457	4040	2460
Gross Beta (pc/l SR_{90}/Y_{90})*	6	<0.064	0.024	0.100	<0.038
		<17	4.4	25	<13

*Elements analyzed only for dissolved fraction

TABLE II-9

SUMMARY OF WATER QUALITY
EVACUATION CREEK AT WATSON (S-6)
March 4, 1975 thru August 4, 1975

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (^{o}C)	10	15.2	9.7	28.2	0.8
Turbidity (JTU)	10	1432	2118	6800	26
Conductance (umhos)	10	4116	1002	5140	1650
Chemical Oxygen Demand (mg/1)	10	77	92	330	32
pH (pH Units)	8	8.3	0.3	8.8	7.9
Carbon Dioxide (mg/1)	8	4.0	3.1	11	1.1
Alkalinity (mg/1 $CACO_3$)	10	334	105	459	128
Bicarbonate (mg/1 HCO_3)	10	399	145	559	129
Carbonate (mg/1 CO_3)	10	4.2	13	42	0
Filterable Residue (mg/1)	5	3180	1221	4200	1300
Oil & Grease (mg/1)	9	8.0	17	52	1
Ammonia (mg/1 N)*	10	0.018	0.015	0.04	0.00
Nitrite (mg/1 N)*	10	0.012	0.016	0.05	0.00
Nitrate (mg/1 N)*	10	1.3	0.6	2.2	0.06
Kjeldahl Nitrogen (mg/1 N)	10	2.1	2.1	7.9	0.96
NO_2 + NO_3 (mg/1 N)*	10	1.3	0.6	2.2	0.09
Orthophosphate (mg/1 PO_4)*	10	0.05	0.05	0.12	0.00
Phosphorous (mg/1)	10	1.2	1.6	4.7	0.01
Orthophosphorous (mg/1 P)*	10	0.017	0.017	0.04	0.00
Total Organic Carbon (mg/1)	2	21	18	34	8.2
Total Inorganic Carbon (mg/1)	0	-	-	-	-
Cyanide (mg/1)	6	0.007	0.004	0.02	0.00
Sulfide (mg/1)*	10	0.08	0.10	0.3	0.0
Hardness (mg/1 Ca, Mg)	10	992	272	1400	340
Non Carbonate Hardness (mg/1)	10	656	181	910	220
Calcium (mg/1)*	10	140	34	200	73
Magnesium (mg/1)*	10	155	46	210	39
Sodium (mg/1)*	10	676	196	980	230
Sodium Adsorption Ratio	10	9.2	1.7	12	5.4
% Sodium	10	59.5	1.7	61	56
Potassium (mg/1)*	10	7.1	2.0	12	5.4
Chloride (mg/1)*	10	39	11	63	18
Sulfate (mg/1)*	10	1998	599	3000	680
Fluoride (mg/1)*	10	0.8	0.2	1.0	0.5
Bromide (mg/1)	10	0.3	0.1	0.4	0.2
Silica (mg/1)*	10	10.6	3.5	17	6.3
Arsenic (mg/1)*	6	0.0017	0.001	0.003	0.000
Barium (mg/1)*	8	<0.057	-	<0.100	-
Beryllium (mg/1)*	5	<0.048	0.0039	0.010	0.0
Bismuth (mg/1)*	3	0.023	-	<0.040	-
Boron (mg/1)*	8	0.939	0.753	2.600	0.210
Cadmium (mg/1)*	8	0	0	0	0.000
Chromium (mg/1)*	8	<0.0046	-	<0.020	-
Cobalt (mg/1)*	8	<0.0031	-	<0.020	-
Copper (mg/1)*	8	0.007	0.0033	0.012	0.003
Iron (mg/1)*	8	0.080	0.068	0.22	0.02
Lead (mg/1)*	8	<0.0038	-	<0.020	-
Manganese (mg/1)*	8	<0.024	0.032	0.10	0.00
Mercury (mg/1)*	6	0	0	0	0.0000
Molybdenum (mg/1)*	8	0.027	0.010	0.043	0.019
Nickel (mg/1)*	8	<0.0049	0.0065	0.020	0.000
Silver (mg/1)*	5	<0.001	0.0014	0.003	0.000
Strontium (mg/1)*	5	2.800	1.433	4.200	1.200
Vanadium (mg/1)*	8	<0.0041	-	<0.020	-
Zinc (mg/1)*	8	0.013	0.013	0.040	0.010
Tin (mg/1)*	3	<0.023	-	<0.040	-
Aluminum (mg/1)*	8	0.047	0.046	0.130	0.010
Gallium (mg/1)*	3	<0.0073	-	<0.010	-
Germanium (mg/1)*	3	<0.021	-	<0.030	-
Lithium (mg/1)*	8	0.067	0.033	0.120	0.020
Selenium (mg/1)*	6	0.0025	0.0015	0.004	0.000
Titanium (mg/1)*	3	<0.018	0.014	0.030	<0.003
Zirconium (mg/1)*	3	<0.033	0.021	<0.050	<0.010
Gross Beta (pc/1 Cs_{137})*	5	<19	4	26	<7
Chlorophyll A (mg/1)	5	0.005	0.008	0.019	0.0000
Chlorophyll B (mg/1)	5	0.0017	0.0018	0.004	0.0000
Phenols (mg/1)	10	0.0054	0.0066	0.024	0.001
Dissolved Solids (mg/1)*	10	3438	981	4920	1170
Gross Alpha (mg/1 U)*	5	< 0.043	0.010	0.067	0.016
Gross Beta (pc/1 SR_{90}/Y_{90})*	5	<17	3	20	<14

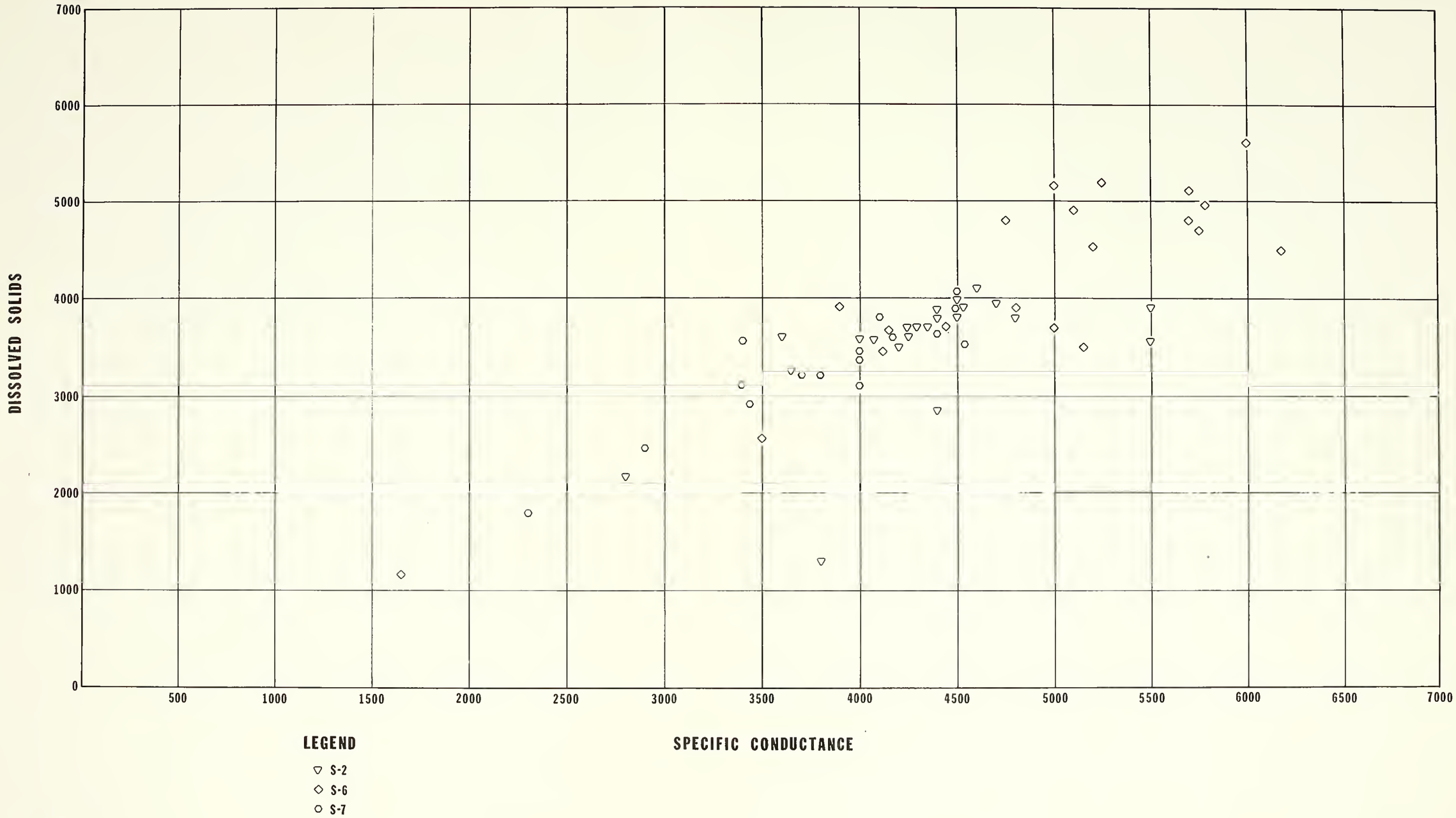
*Elements analyzed only for dissolved fraction

TABLE II-10

SUMMARY OF WATER QUALITY
EVACUATION CREEK NEAR MOUTH (S-2)
March 4, 1975 thru August 4, 1975

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (°C)	10	15.6	8.6	30	5.2
Turbidity (JTU)	10	777	1084	2800	3
Conductance (umhos)	10	4014	556	4800	2800
Chemical Oxygen Demand (mg/l)	10	47	30	110	22
pH (pH Units)	7	7.9	0.2	8.2	7.5
Carbon Dioxide (mg/l)	7	10	7.0	24	3.8
Alkalinity (mg/l $CACO_3$)	10	366	57	438	247
Bicarbonate (mg/l HCO_3)	10	447	70	534	301
Carbonate (mg/l CO_3)	9	0	0	0	0
Filterable Residue (mg/l)	5	3140	684	3800	2200
Oil & Grease (mg/l)	10	2.7	2.5	9	0
Ammonia (mg/l N)*	10	0.04	0.03	0.10	0.01
Nitrite (mg/l N)*	10	0.03	0.03	0.11	0.00
Nitrate (mg/l N)*	10	1.3	0.3	1.8	0.92
Kjeldahl Nitrogen (mg/l N)	10	1.4	1.4	5.0	0.39
NO_2 + NO_3 (mg/l N)*	10	1.3	0.3	1.8	0.96
Orthophosphate (mg/l PO_4)*	10	0.05	0.03	0.12	0.00
Phosphorous (mg/l)	10	0.17	0.18	0.52	0.00
Orthophosphorous (mg/l P)*	10	0.02	0.01	0.04	0.00
Total Organic Carbon (mg/l)	2	8.1	0.07	8.2	8.1
Total Inorganic Carbon (mg/l)	0	-	-	-	-
Cyanide (mg/l)	6	0.003	0.005	0.01	0.00
Sulfide (mg/l)*	10	0.06	0.07	0.2	0.0
Hardness (mg/l Ca, Mg)	10	1046	140	1200	690
Non Carbonate Hardness (mg/l)	10	669	90	770	440
Calcium (mg/l)*	10	157	24	190	110
Magnesium (mg/l)*	10	156	22	180	100
Sodium (mg/l)*	10	666	95	730	420
Sodium Adsorption Ratio	10	9.0	0.9	10	7.0
% Sodium	10	58	1.8	61	55
Potassium (mg/l)*	10	8.1	1.2	10	6.2
Chloride (mg/l)*	10	43	7	48	25
Sulfate (mg/l)*	10	1990	300	2200	1200
Fluoride (mg/l)*	10	0.77	0.11	0.9	0.5
Bromide (mg/l)	10	0.3	0.1	0.4	0.2
Silica (mg/l)*	10	10	2	14	6.1
Arsenic (mg/l)*	6	0.0008	0.0006	0.002	0.000
Barium (mg/l)*	6	<0.050	0.055	0.1	0.0
Beryllium (mg/l)*	2	<0.0050	0.0071	0.010	0.000
Bismuth (mg/l)*	0	-	-	-	-
Boron (mg/l)*	6	1.263	0.422	1.700	0.590
Cadmium (mg/l)*	6	0.00033	0.00052	0.001	0.000
Chromium (mg/l)*	6	0.000	0.000	0.000	0.000
Cobalt (mg/l)*	6	0.00033	0.00082	0.002	0.000
Copper (mg/l)*	6	0.132	0.237	0.600	0.006
Iron (mg/l)*	6	0.072	0.073	0.20	0.01
Lead (mg/l)*	6	0.0015	0.0016	0.004	0.000
Manganese (mg/l)*	6	0.045	0.024	0.09	0.02
Mercury (mg/l)*	6	0.00003	0.00008	0.0002	0.0000
Molybdenum (mg/l)*	6	0.034	0.009	0.044	0.020
Nickel (mg/l)*	6	0.0033	0.0023	0.006	0.000
Silver (mg/l)*	2	0.000	0.000	0.000	0.000
Strontium (mg/l)*	2	3.750	0.071	3.800	3.700
Vanadium (mg/l)*	6	0.00045	0.00054	0.0013	0.0000
Zinc (mg/l)*	6	0.027	0.025	0.070	0.00
Tin (mg/l)*	0	-	-	-	-
Aluminum (mg/l)*	6	0.053	0.049	0.110	0.000
Gallium (mg/l)*	0	-	-	-	-
Germanium (mg/l)*	0	-	-	-	--
Lithium (mg/l)*	6	0.093	0.025	0.120	0.050
Selenium (mg/l)*	6	0.0028	0.0010	0.004	0.002
Titanium (mg/l)*	0	-	-	-	-
Zirconium (mg/l)*	0	-	-	-	-
Gross Beta (pc/l Cs_{137})*	5	<20	7.5	29	<9.5
Chlorophyll A (mg/l)	5	0.0058	0.0076	0.018	0.0000
Chlorophyll B (mg/l)	5	0.0033	0.0041	0.010	0.0002
Phenols (mg/l)	10	0.0036	0.0024	0.008	0.001
Dissolved Solids (mg/l)*	10	3476	493	3820	2150
Gross Alpha (mg/l U)*	5	<0.057	0.033	0.110	<0.023
Gross Beta (pc/l SR_{90}/Y_{90})*	5	<16	6.2	23	<7.5

*Elements analyzed only for dissolved fraction



RELATION BETWEEN SPECIFIC CONDUCTANCE AND DISSOLVED SOLIDS

EVACUATION CREEK

AUGUST, 1974 - SEPTEMBER, 1975

FIGURE II-12

TABLE II-11

WATER QUALITY RESULTS FROM THE WASHES 1975

	Hell's Hole Canyon At Mouth (S-5) July 16	Hell's Hole Canyon At Mouth (S-5) Aug. 18	Asphalt Wash At Mouth (S-12) Aug. 14
Temperature (°C)	-	-	-
Turbidity (JTU)	-	190	2300
Conductance (umhos)	2020	-	-
Chemical Oxygen Demand (mg/l)	-	-	-
pH (pH Units)	-	-	-
Carbon Dioxide (mg/l)	-	-	-
Alkalinity (mg/l $CACO_3$)	189	93	189
Bicarbonate (mg/l HCO_3)	231	113	230
Carbonate (mg/l CO_3)	-	-	-
Filterable Residue (mg/l)	-	-	-
Oil & Grease (mg/l)	-	-	-
Ammonia (mg/l N)*	-	0.00	0.00
Nitrite (mg/l N)*	-	0.12	0.06
Nitrate (mg/l N)*	-	0.77	3.4
Kjeldahl Nitrogen (mg/l N)	-	1.5	4.4
NO_2 + NO_3 (mg/l N)*	0.04	0.89	3.5
Orthophosphate (mg/l PO_4)*	0.00	0.00	0.34
Phosphorous (mg/l)	-	0.07	5.9
Orthophosphorous (mg/l P)*	0.00	0.00	0.11
Total Organic Carbon (mg/l)	-	-	-
Total Inorganic Carbon (mg/l)	-	-	-
Cyanide (mg/l)	-	-	-
Sulfide (mg/l)*	-	0.2	0.2
Hardness (mg/l Ca, Mg)	810	290	68
Non Carbonate Hardness (mg/l)	620	200	0
Calcium (mg/l)*	260	84	19
Magnesium (mg/l)*	38	19	4.9
Sodium (mg/l)*	160	39	84
Sodium Adsorption Ratio	2.5	1.0	4.4
% Sodium	30	22	71
Potassium (mg/l)*	11	7	5.5
Chloride (mg/l)*	9.0	4.1	12
Sulfate (mg/l)*	950	260	34
Fluoride (mg/l)*	0.4	0.4	0.5
Silica (mg/l)*	15	7.5	14
Arsenic (mg/l)*	-	0.001	0.037
Barium (mg/l)*	-	-	-
Beryllium (mg/l)*	-	-	-
Bismuth (mg/l)*	-	-	-
Boron (mg/l)*	0.210	0.090	0.280
Cadmium (mg/l)*	-	-	-
Chromium (mg/l)*	-	-	-
Cobalt (mg/l)*	-	-	-
Copper (mg/l)*	-	0.017	0.045
Iron (mg/l)*	0.420	0.070	0.240
Lead (mg/l)*	-	-	-
Manganese (mg/l)*	0.520	-	-
Mercury (mg/l)*	-	0.0000	0.0000
Molybdenum (mg/l)*	-	-	-
Nickel (mg/l)*	-	-	-
Silver (mg/l)*	-	-	-
Strontium (mg/l)*	-	0.890	0.340
Vanadium (mg/l)*	-	-	-
Zinc (mg/l)*	-	0.130	0.120
Tin (mg/l)*	-	-	-
Aluminum (mg/l)*	-	0.000	0.090
Gallium (mg/l)*	-	-	-
Germanium (mg/l)*	-	-	-
Lithium (mg/l)*	-	0.010	0.040
Selenium (mg/l)*	-	0.002	0.001
Titanium (mg/l)*	-	-	-
Zirconium (mg/l)*	-	-	-
Gross Beta (mg/l Cs_{137})*	-	-	-
Chlorophyll A (mg/l)	-	-	-
Chlorophyll B (mg/l)	-	-	-
Phenols (mg/l)	-	-	-
Dissolved Solids (mg/l)*	-	500	351
Gross Alpha (mg/l U)*	-	-	-
Gross Beta (mg/l SR_{90}/Y_{90})*	-	-	-

*Elements analyzed only for dissolved fraction

sodium, and bicarbonate predominating in water in which the dissolved solids level is less than 60 percent of the Hells Hole Canyon samples. It is possible that the differences in quality reflect differences in the time during the flow event at which the samples were taken rather than the differences in overall quality.

3. GROUND WATER LEVEL MONITORING

Figure II-13 is based on monthly water level measurements taken with an electric probe and steel tape for data collected through early December 1975. These data were previously in tabular form. The entire data collection interval now exceeds slightly more than one full year of static water-level measurements. Water level fluctuations over the period of record are small in wells tapping the bird's nest aquifer.

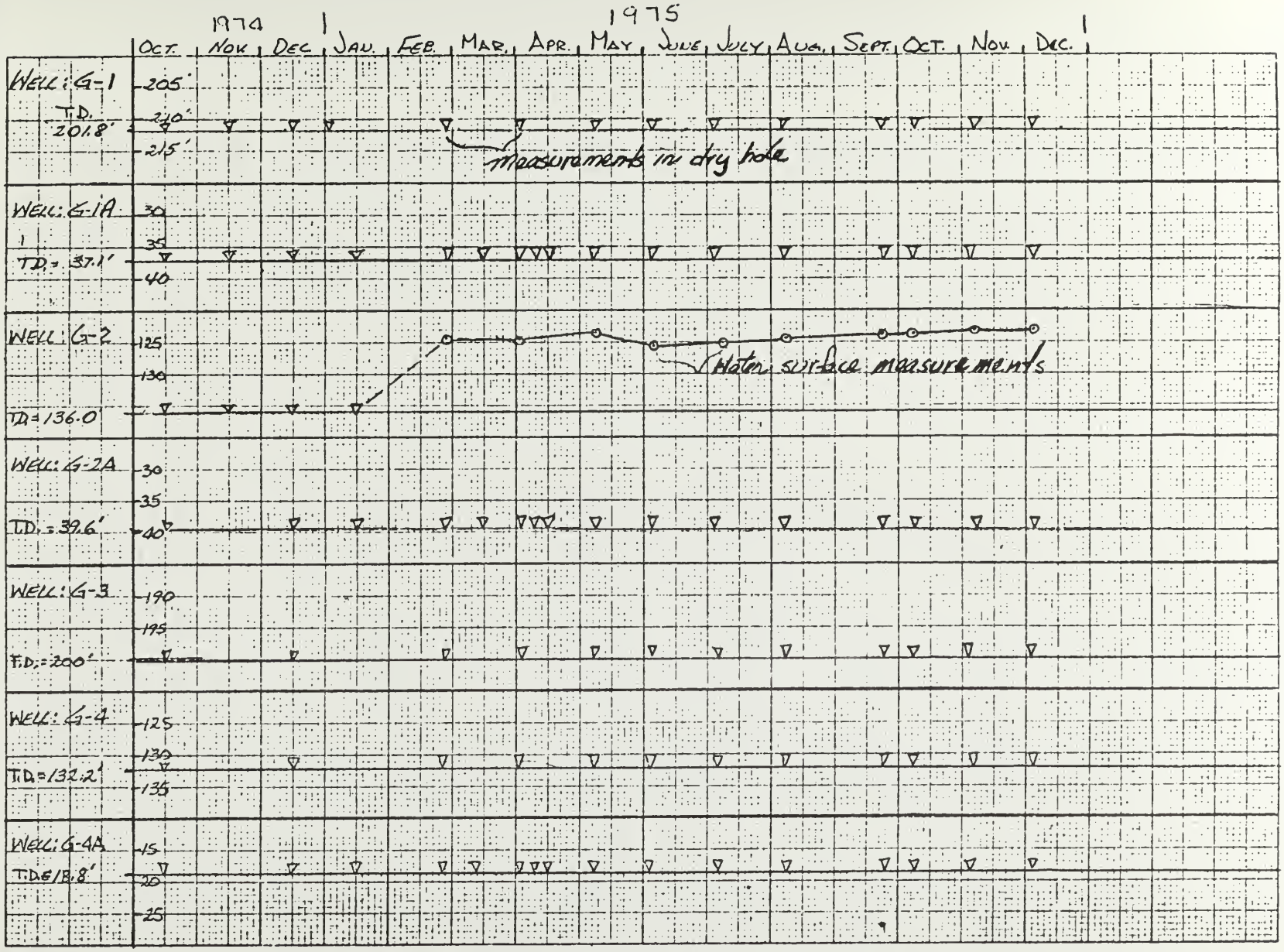
Well G-16A derives its water from the top of the Douglas Creek Member of the Green River Formation. Based upon static head and similar water quality, Well P-4 may be receiving water from the same source by upward leakage around an imperfect grout seal.

Other recorded wells tapping other than the bird's nest aquifer are the alluvial Wells G-1A, 2A, 4A, 13A, 16B, and 18A. Wells G-1A, 2A, and 4A in the Southam Canyon drainage area have been dry throughout the period of record, as has been Well G-16B in the Evacuation Creek drainage area. Wells G-13A and 18A also in the Evacuation Creek drainage have contained water throughout all or most of the period of record.

Well P-2 upper gets its water from a zone near the contact of the Uinta and Green River Formations. It was the only location where water was found in this stratigraphic interval.

4. GROUND WATER QUALITY

The samples collected in November and December as part of the semi-annual pumped quality sample program have not yet been analysed. Tables II-12 through II-15 show the statistical comparison of samples collected to date. These have been separated into alluvial, bird's nest, and Douglas Creek Member aquifer water, respectively. The bird's nest water was further divided into two subareas based upon water quality differences across a line drawn diagonally from Section 26 in Tract U-b and northwest across Section 21 in Tract U-a.



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS
OCT. 1974 - DEC. 1975 WHITE RIVER SHALE PROJECT
TRACTS Ua - Ub

FIGURE II-13

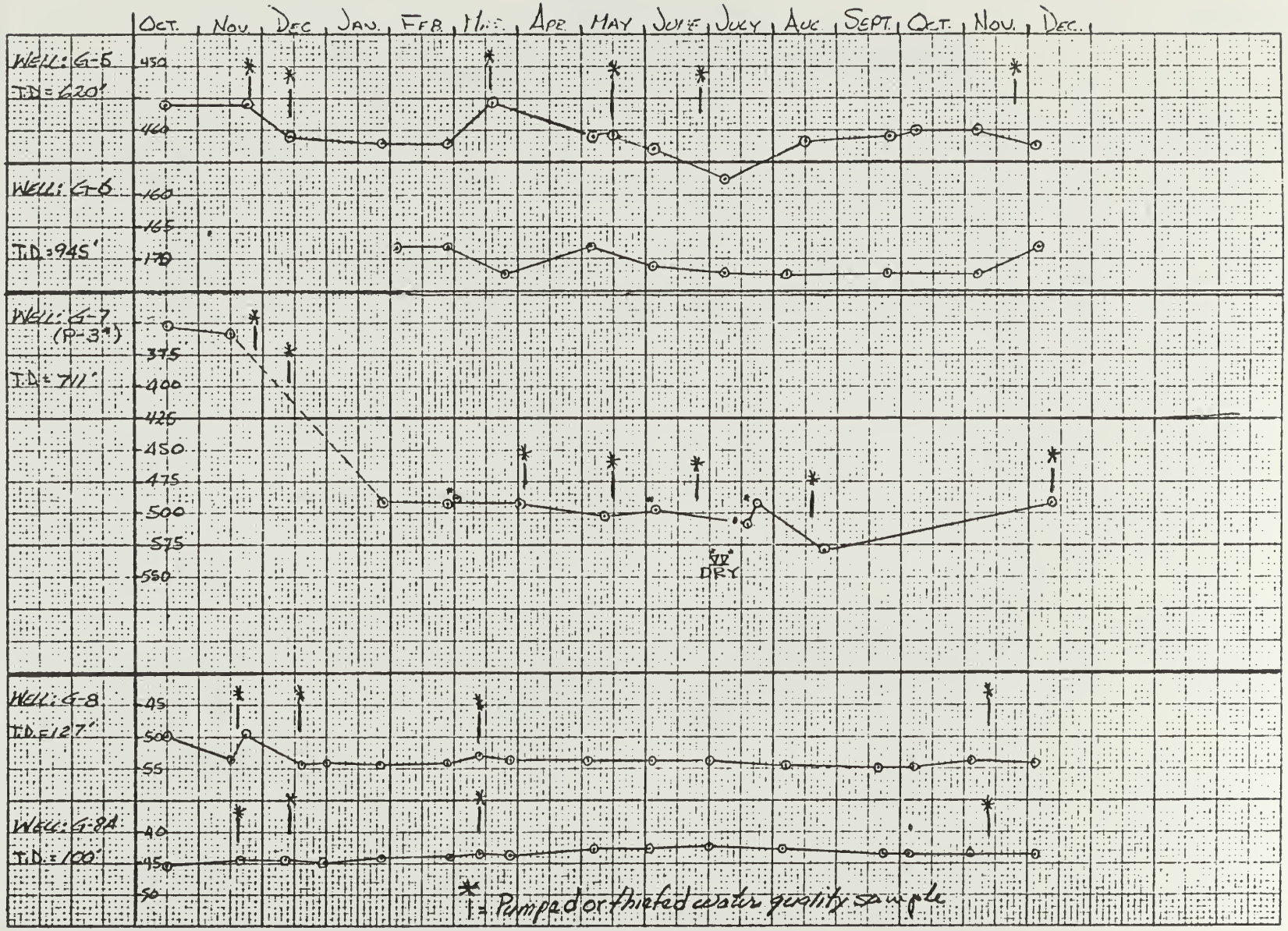


FIGURE II-13: CONT'D

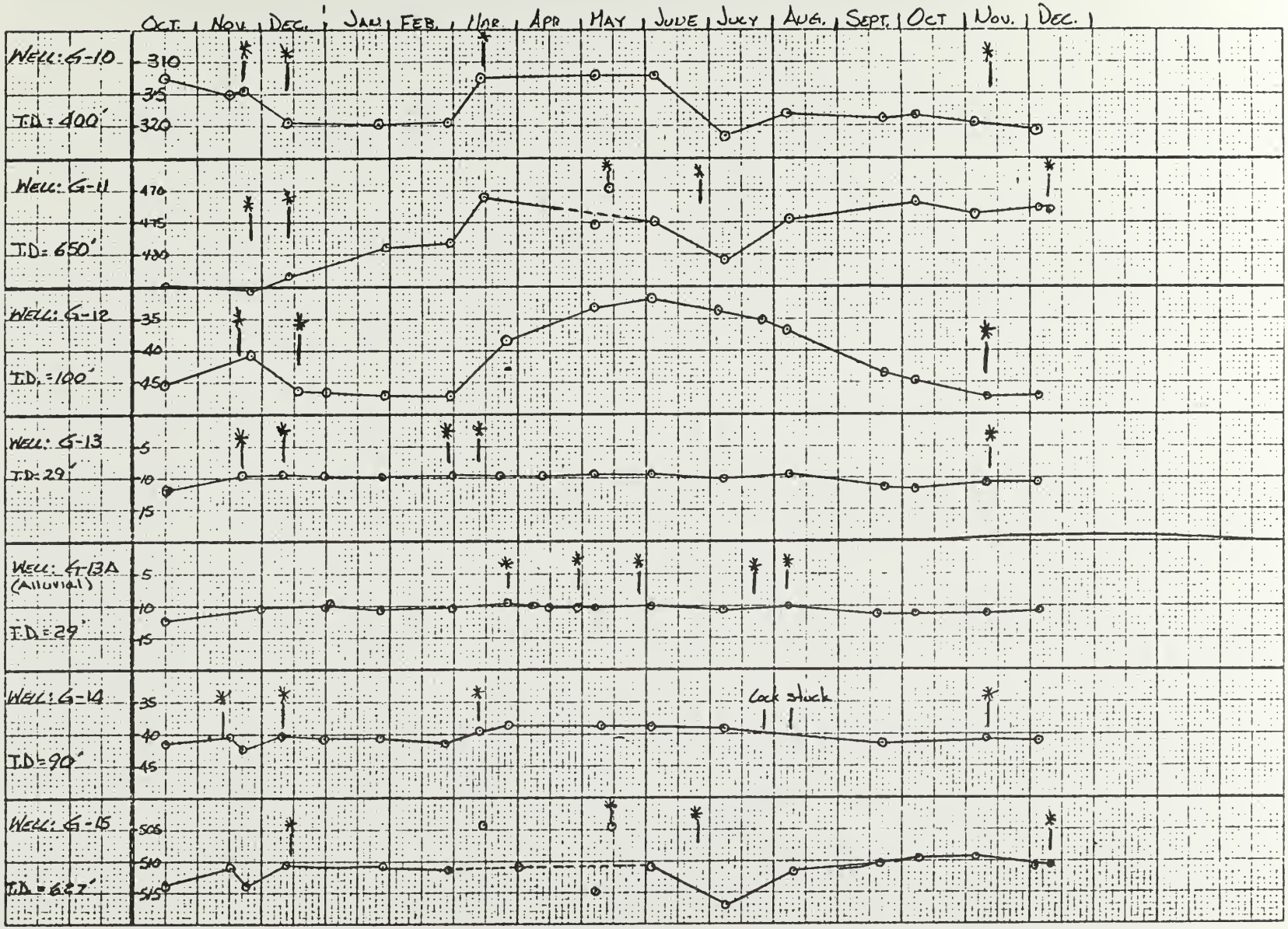


FIGURE II-13: CONT'D

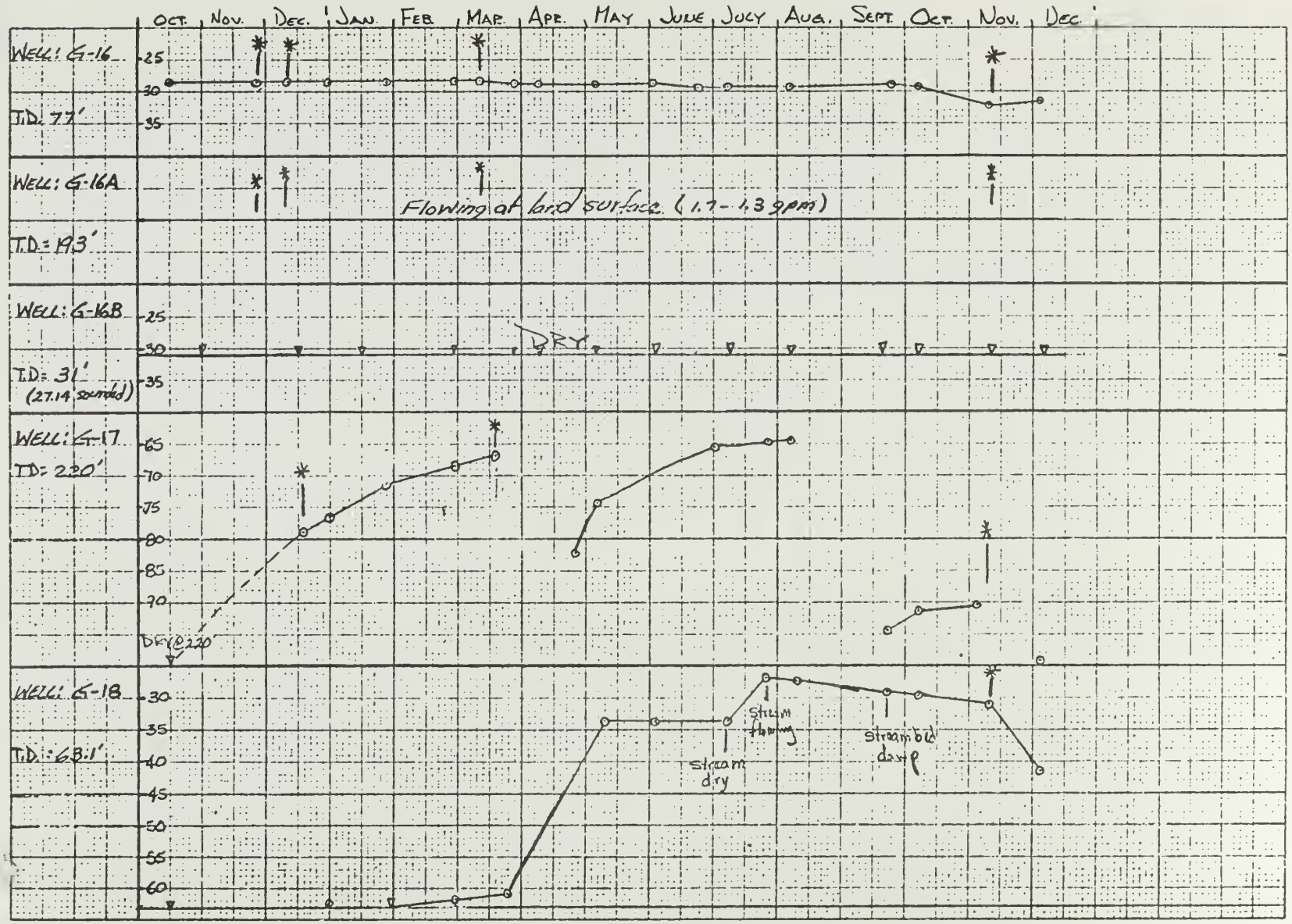


FIGURE II-13: CONT'D

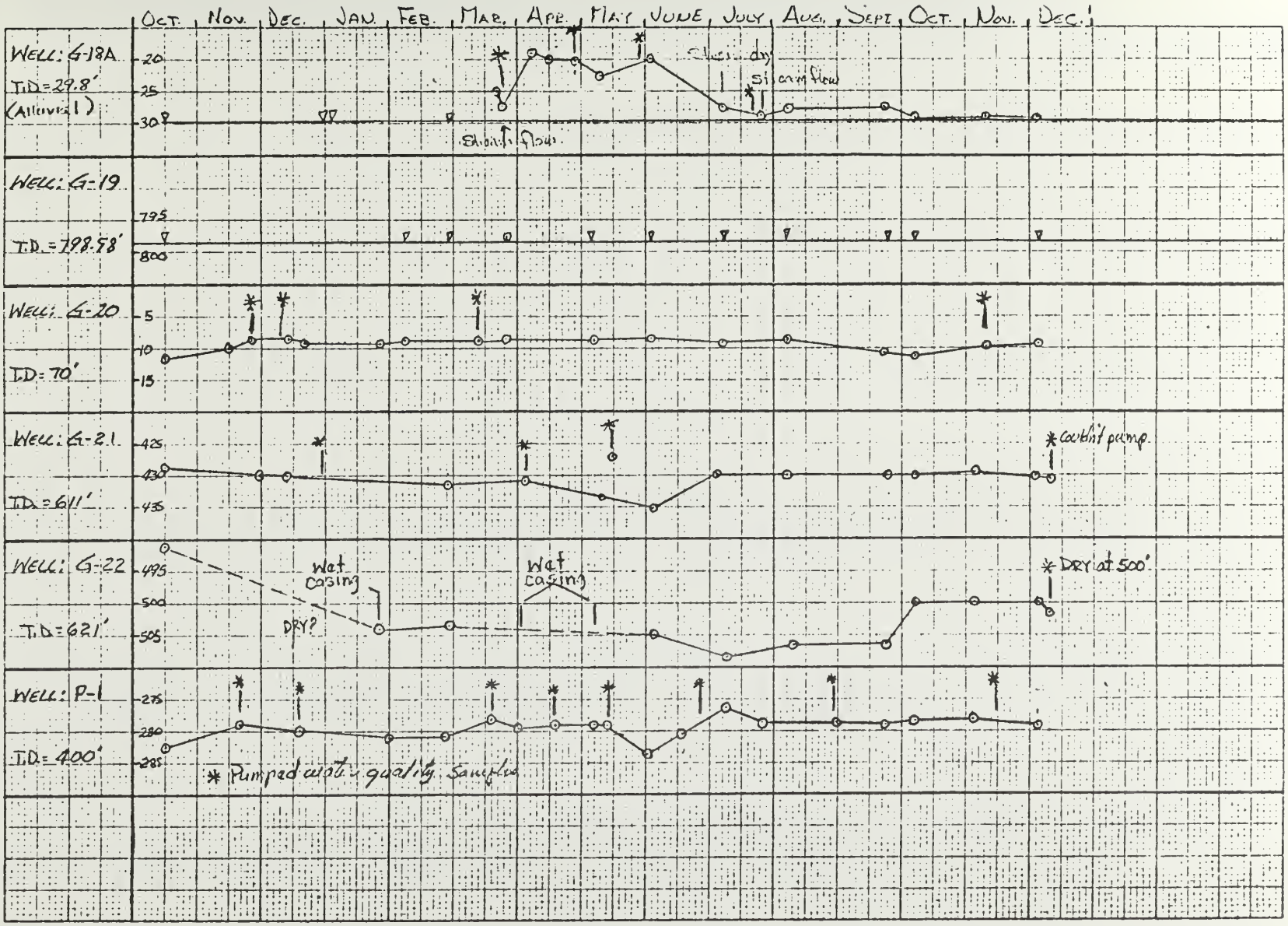


FIGURE II-13: CONT'D

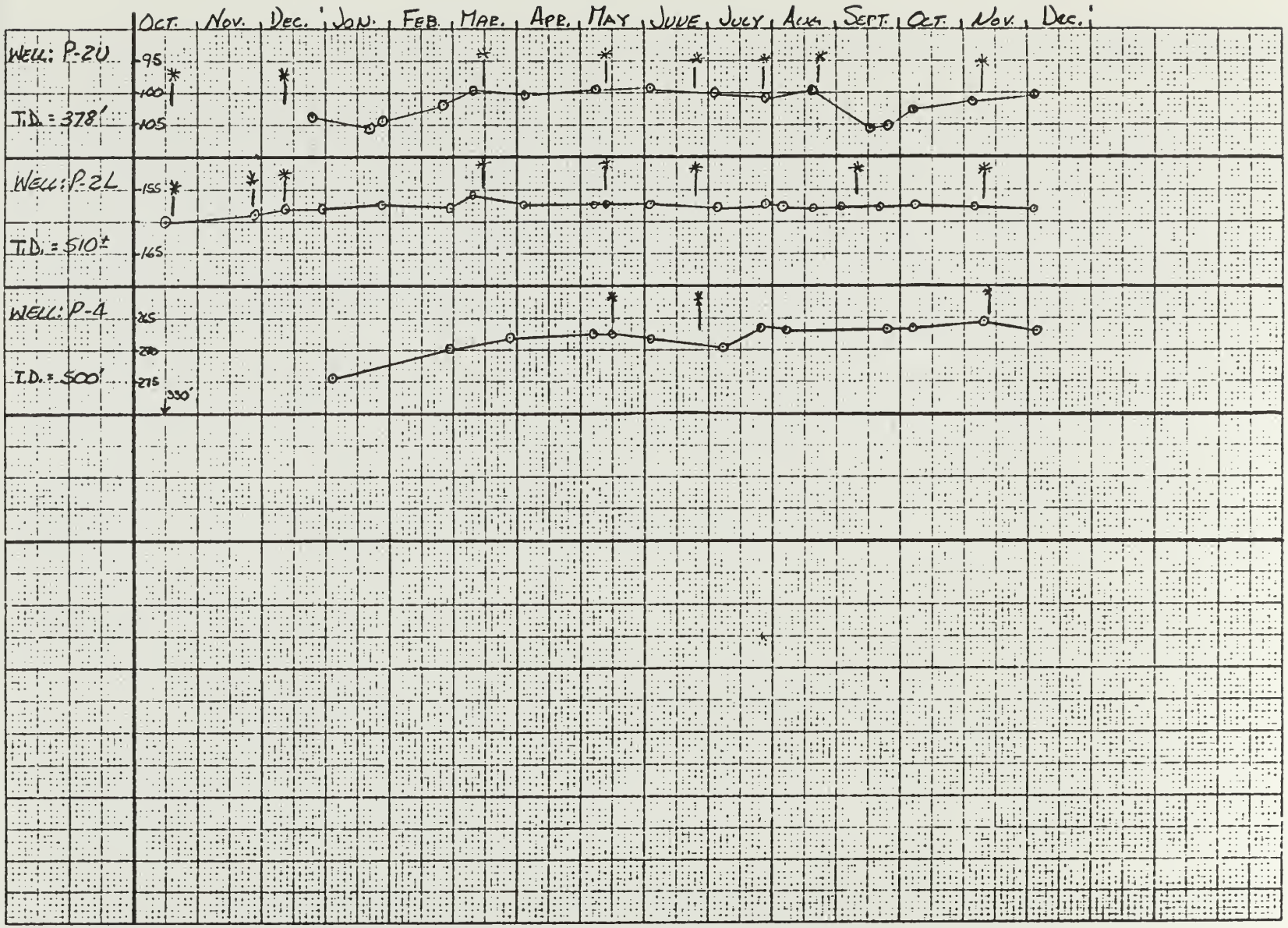


FIGURE II-13: CONT'D

TABLE II-12

SUMMARY OF GROUND WATER QUALITY
ALLUVIAL WELLS (G-13A, G-18A)
March 24, 1975 thru August 6, 1975

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (^{o}C)	6	13.0	9.6	32.2	7.1
Turbidity (JTU)	-	-	-	-	-
Conductance (umhos)	8	4775	2118	8000	3700
Chemical Oxygen Demand (mg/l)	8	75	38	160	34
pH (pH Units)	6	10.8	2.2	13.6	7.9
Carbon Dioxide (mg/l)	6	1.2	2.4	6.0	0.0
Alkalinity (mg/l $CACO_3$)	8	521	464	1530	66
Bicarbonate (mg/l HCO_3)	8	279	262	746	0
Carbonate (mg/l CO_3)	8	13	16	38	0
Filterable Residue (mg/l)	5	4120	988	5000	3000
Oil & Grease (mg/l)	8	2.1	0.8	3	1
Ammonia (mg/l N)*	8	0.15	0.17	0.50	0.03
Nitrite (mg/l N)*	8	0.22	0.31	0.77	0.00
Nitrate (mg/l N)*	8	0.36	0.48	1.5	0.00
Kjeldahl Nitrogen (mg/l N)	8	1.3	0.4	1.8	0.62
NO_2 + NO_3 (mg/l N)*	8	0.58	0.60	1.8	0.00
Orthophosphate (mg/l PO_4)*	8	0.05	0.05	0.12	0.00
Phosphorous (mg/l)	8	0.09	0.07	0.21	0.00
Orthophosphorous (mg/l P)*	8	0.02	0.01	0.04	0.00
Total Organic Carbon (mg/l)	8	14	16	60	13
Total Inorganic Carbon (mg/l)	1	136	-	136	-
Cyanide (mg/l)	-	-	-	-	-
Sulfide (mg/l)*	7	0.04	0.08	0.2	0.0
Hardness (mg/l Ca, Mg)	8	1085	266	1500	700
Non Carbonate Hardness (mg/l)	8	840	297	1400	420
Calcium (mg/l)*	8	274	151	580	130
Magnesium (mg/l)*	8	96	93	200	0.2
Sodium (mg/l)*	8	757	142	930	550
Sodium Adsorption Ratio	8	10	2	13	6.3
% Sodium	8	60	7	67	45
Potassium (mg/l)*	8	15	6	25	9.5
Chloride (mg/l)*	8	52	8	63	44
Sulfate (mg/l)*	8	2060	676	2800	1000
Fluoride (mg/l)*	8	0.55	0.30	1.0	0.2
Silica (mg/l)*	8	5.5	3.7	9.3	1.0
Arsenic (mg/l)*	8	0.001	0.0005	0.002	0.000
Barium (mg/l)*	8	0.065	0.076	0.200	0.000
Beryllium (mg/l)*	8	<0.0038	0.0045	<0.010	0.000
Bismuth (mg/l)*	2	<0.0325	0.0106	<0.040	<0.025
Boron (mg/l)*	10	0.931	0.778	2.0	0.040
Cadmium (mg/l)*	8	0.000	0	0	0
Chromium (mg/l)*	8	<0.0106	0.0127	<0.030	0
Cobalt (mg/l)*	10	<0.0052	0.0107	<0.030	0
Copper (mg/l)*	9	0.163	0.247	0.770	0.012
Iron (mg/l)*	8	0.031	0.023	0.070	0.010
Lead (mg/l)*	10	0.025	0.051	0.160	0
Manganese (mg/l)*	9	0.097	0.148	0.400	0
Mercury (mg/l)*	8	0.00001	0.00003	0.0001	0.0
Molybdenum (mg/l)*	8	0.093	0.072	0.250	0.036
Nickel (mg/l)*	10	0.013	0.021	0.065	0.0
Silver (mg/l)*	10	<0.0005	0.001	<0.003	0.0
Strontium (mg/l)*	8	3.04	1.15	5.00	1.80
Vanadium (mg/l)*	10	0.0056	0.0105	<0.030	0.0
Zinc (mg/l)*	9	0.095	0.173	0.530	0.010
Tin (mg/l)*	2	0.025	0.007	<0.030	<0.020
Aluminum (mg/l)*	6	0.032	0.012	0.050	0.020
Gallium (mg/l)*	2	<0.009	0.0014	<0.010	<0.008
Germanium (mg/l)*	2	<0.035	0.014	<0.045	<0.025
Lithium (mg/l)*	10	<0.111	0.015	0.130	0.090
Selenium (mg/l)*	6	0.0032	0.001	0.004	0.002
Titanium (mg/l)*	2	0.230	0.099	0.30	0.16
Zirconium (mg/l)*	2	0.035	0.014	0.045	0.025
Gross Beta (pc/l Cs_{137})*	5	40.6	28.9	92	24
Chlorophyll A (mg/l)	-	-	-	-	-
Chlorophyll B (mg/l)	-	-	-	-	-
Phenols (mg/l)	-	-	-	-	-
Dissolved Solids (mg/l)*	8	3744	746	4580	2890
Gross Alpha (mg/l U)*	5	<0.108	0.130	0.340	<0.033
Gross Beta (pc/l SR_{90}/Y_{90})*	5	<3.4	2.5	7.8	2.1

*Elements analyzed only for dissolved fraction

TABLE II-13
SUMMARY OF GROUND WATER QUALITY
BIRDS NEST AQUIFER (N.E.)
November 19, 1974 thru August 17, 1975
(G-14, G-5, G-11, G-10, G-8, G-8A, P-1)

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (^{o}C)	26	14.2	2.5	17.3	10.3
Turbidity (JTU)	---	---	---	---	---
Conductance (umhos)	29	4418	1336	6070	1130
Chemical Oxygen Demand (mg/1)	30	142	204	830	4
pH (pH Units)	23	8.1	1.0	11.4	7.2
Carbon Dioxide (mg/1)	23	19.8	15.6	46	0
Alkalinity (mg/1 $CACO_3$)	30	594	253	1290	216
Bicarbonate (mg/1 HCO_3)	30	660	301	1410	26
Carbonate (mg/1 CO_3)	29	28	69	301	0
Filterable Residue (mg/1)	29	3805	1409	5200	590
Oil & Grease (mg/1)	30	4.0	4.2	21	0
Ammonia (mg/1 N)*	30	2.2	4.3	15	0.02
Nitrite (mg/1 N)*	30	0.01	0.02	0.08	0
Nitrate (mg/1 N)*	30	0.03	0.07	0.31	0
Kjeldahl Nitrogen (mg/1 N)	30	3.3	7.8	39	0.05
NO_2 + NO_3 (mg/1 N)*	30	0.04	0.09	0.39	0
Orthophosphate (mg/1 PO_4)*	30	0.16	0.27	1.20	0
Phosphorous (mg/1)	30	0.14	0.23	0.90	0
Orthophosphorous (mg/1 P)*	30	0.05	0.09	0.32	0
Total Organic Carbon (mg/1)	30	34	74	360	8
Total Inorganic Carbon (mg/1)	17	22	46	149	0
Cyanide (mg/1)	---	---	---	---	---
Sulfide (mg/1)*	30	45	70	240	0
Hardness (mg/1 Ca, Mg)	30	761	501	1400	12
Non Carbonate Hardness (mg/1)	30	389	371	980	0
Calcium (mg/1)*	30	107	79	210	3.4
Magnesium (mg/1)*	30	120	81	220	0
Sodium (mg/1)*	30	827	297	1300	72
Sodium Adsorption Ratio	30	21	18	66	1.8
% Sodium	30	71	17	98	34
Potassium (mg/1)*	30	6.0	2.5	11	2.3
Chloride (mg/1)*	30	132	153	580	36
Sulfate (mg/1)*	30	1738	1012	3000	91
Fluoride (mg/1)*	30	1.28	0.75	3.2	0.6
Silica (mg/1)*	30	17	8	27	2.3
Arsenic (mg/1)*	30	0.016	0.027	0.150	0.001
Barium (mg/1)*	35	<0.140	0.179	1.00	0
Beryllium (mg/1)*	35	<0.008	0.003	<0.010	0
Bismuth (mg/1)*	30	<0.027	0.017	<0.064	<0.003
Boron (mg/1)*	35	2.73	2.13	8.20	0.030
Cadmium (mg/1)*	35	0.0002	0.0004	0.001	0
Chromium (mg/1)*	35	<0.010	0.009	<0.027	0
Cobalt (mg/1)*	35	<0.005	0.008	<0.027	0
Copper (mg/1)*	32	<0.006	0.013	0.065	0
Iron (mg/1)*	34	<0.39	0.47	2.30	0.002
Lead (mg/1)*	34	<0.020	0.070	0.40	0
Manganese (mg/1)*	35	0.046	0.056	0.23	0
Mercury (mg/1)*	28	<0.00004	0.00006	0.0002	0
Molybdenum (mg/1)*	35	<0.030	0.031	0.10	0
Nickel (mg/1)*	35	<0.011	0.019	0.10	0
Silver (mg/1)*	35	<0.0007	0.001	<0.003	0
Strontium (mg/1)*	35	5.80	3.72	11.0	0.06
Vanadium (mg/1)*	35	<0.007	0.009	<0.027	0
Zinc (mg/1)*	35	0.038	0.037	0.190	0
Tin (mg/1)*	30	<0.028	0.018	<0.080	<0.003
Aluminum (mg/1)*	33	<0.050	0.080	0.330	0
Gallium (mg/1)*	30	<0.011	0.008	<0.035	<0.001
Germanium (mg/1)*	30	<0.029	0.018	<0.080	<0.003
Lithium (mg/1)*	35	0.52	0.40	1.40	0
Selenium (mg/1)*	30	0.0005	0.001	0.005	0
Titanium (mg/1)*	30	<0.021	0.012	<0.050	<0.003
Zirconium (mg/1)*	30	<0.039	0.025	<0.10	0.005
Gross Beta (pc/1 Cs_{137})*	29	<16.8	9.4	40	<6
Chlorophyll A (mg/1)	---	---	---	---	---
Chlorophyll B (mg/1)	---	---	---	---	---
Phenols (mg/1)	---	---	---	---	---
Dissolved Solids (mg/1)*	29	3298	1487	4760	494
Gross Alpha (mg/1 U)*	29	<0.045	0.020	<0.071	<0.0062
Gross Beta (pc/1 SR_{90}/Y_{90})*	29	<13.7	7.6	<30	<3.8

*Elements analyzed only for dissolved fraction

TABLE II-14
SUMMARY OF GROUND WATER QUALITY
BIRDS NEST AQUIFER (S.W.)
October 18, 1974 thru August 19, 1975
(G-16, G-13, G-20, G-12, G-15, G-21, P-2U, P-2L)

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (^{o}C)	31	13.9	3.1	18.5	8.0
Turbidity (JTU)	--	---	---	---	---
Conductance (umhos)	35	3205	1530	6100	350
Chemical Oxygen Demand (mg/1)	33	96	84	320	8
pH (pH Units)	29	8.6	0.9	10.7	7.6
Carbon Dioxide (mg/1)	29	8.4	12.5	61	0
Alkalinity (mg/1 $CACO_3$)	35	694	422	2750	417
Bicarbonate (mg/1 HCO_3)	35	705	266	1710	63
Carbonate (mg/1 CO_3)	35	70	150	808	0
Filterable Residue (mg/1)	31	2750	1430	5200	180
Oil & Grease (mg/1)	32	2.7	2.4	12	0
Ammonia (mg/1 N)*	35	1.3	1.4	8.1	0.04
Nitrite (mg/1 N)*	33	0.03	0.11	0.65	0
Nitrate (mg/1 N)*	31	0.04	0.09	0.46	0
Kjeldahl Nitrogen (mg/1 N)	35	2.1	2.2	12	0.51
NO_2 + NO_3 (mg/1 N)*	32	0.05	0.10	0.48	0
Orthophosphate (mg/1 PO_4)*	34	0.16	0.19	0.98	0
Phosphorous (mg/1)	35	0.17	0.33	1.4	0.01
Orthophosphorous (mg/1 P)*	34	0.05	0.06	0.32	0
Total Organic Carbon (mg/1)	33	19	19	66	2.3
Total Inorganic Carbon (mg/1)	16	35	71	258	0
Cyanide (mg/1)	--	---	---	---	---
Sulfide (mg/1)*	29	53	85	340	0
Hardness (mg/1 Ca, Mg)	35	378	451	1400	1.0
Non Carbonate Hardness (mg/1)	35	214	267	730	0
Calcium (mg/1)*	35	46	63	180	0
Magnesium (mg/1)*	35	72	77	190	1.0
Sodium (mg/1)*	35	692	261	1500	300
Sodium Adsorption Ratio	35	30	40	234	5.4
% Sodium	35	82	15	100	41
Potassium (mg/1)*	35	4.5	3.8	16	1.4
Chloride (mg/1)*	34	88	86	390	31
Sulfate (mg/1)*	34	1110	883	2700	120
Fluoride (mg/1)*	34	2.1	1.7	6.7	0.4
Silica (mg/1)*	34	15	4.7	23	6.2
Arsenic (mg/1)*	35	0.020	0.025	0.095	0
Barium (mg/1)*	42	<0.071	0.041	0.120	0
Beryllium (mg/1)*	42	<0.007	0.004	0.010	0
Bismuth (mg/1)*	34	<0.022	0.015	<0.070	<0.007
Boron (mg/1)*	44	3.53	6.47	33.0	0.14
Cadmium (mg/1)*	42	<0.009	0.040	<0.23	0
Chromium (mg/1)*	42	<8.5	7.2	0.025	0
Cobalt (mg/1)*	42	<0.004	0.006	<0.02	0
Copper (mg/1)*	44	<0.007	0.010	0.044	0
Iron (mg/1)*	44	0.30	0.60	3.80	0.01
Lead (mg/1)*	42	<0.004	0.006	0.002	0
Manganese (mg/1)*	42	<0.039	0.048	0.25	0
Mercury (mg/1)*	28	<0.00006	0.00006	0.0002	0
Molybdenum (mg/1)*	42	0.047	0.058	0.260	0
Nickel (mg/1)*	42	0.008	0.008	0.042	0
Silver (mg/1)*	42	<0.0005	0.0005	<0.002	0
Strontium (mg/1)*	44	2.60	1.83	7.7	0.06
Vanadium (mg/1)*	42	<0.004	0.005	0.017	0
Zinc (mg/1)*	41	0.024	0.021	0.080	0
Tin (mg/1)*	34	<0.023	0.017	<0.027	<0.007
Aluminum (mg/1)*	42	<0.047	0.078	0.40	0
Gallium (mg/1)*	34	<0.010	0.007	0.03	0.003
Germanium (mg/1)*	34	<0.023	0.017	<0.075	<0.007
Lithium (mg/1)*	44	0.37	0.17	0.81	0.10
Selenium (mg/1)*	35	0.0015	0.0044	0.022	0
Titanium (mg/1)*	34	<0.016	0.012	<0.042	<0.004
Zirconium (mg/1)*	34	<0.031	0.024	<0.10	<0.009
Gross Beta (pc/1 Cs_{137})*	31	<11.9	6.9	<27	<4.8
Chlorophyll A (mg/1)	--	---	---	---	---
Chlorophyll B (mg/1)	--	---	---	---	---
Phenols (mg/1)	--	---	---	---	---
Dissolved Solids (mg/1)*	35	2538	1282	4640	878
Gross Alpha (mg/1 U)*	31	<0.034	0.019	0.083	<0.015
Gross Beta (pc/1 SR_{90}/Y_{90})*	31	<9.9	5.8	24	<3.5

*Elements analyzed only for dissolved fraction

TABLE II-15

SUMMARY OF GROUND WATER QUALITY
DOUGLAS CREEK AQUIFER (G-16A, P-4)
November 26, 1974 through June 26, 1974

	Number Of Samples	Mean	Standard Deviation	Maximum	Minimum
Temperature (°C)	5	12.8	2.0	15.3	10.5
Turbidity (JTU)	-	-	-	-	-
Conductance (umhos)	5	1480	170	1720	1350
Chemical Oxygen Demand (mg/1)	5	95	121	260	7
pH (pH Units)	4	10.2	0.7	10.9	9.3
Carbon Dioxide (mg/1)	4	0.22	0.33	0.7	0.0
Alkalinity (mg/1 $CACO_3$)	5	660	146	817	500
Bicarbonate (mg/1 HCO_3)	5	639	91	753	522
Carbonate (mg/1 CO_3)	5	82	58	138	0
Filterable Residue (mg/1)	5	1110	201	1400	910
Oil & Grease (mg/1)	5	2.2	2.5	4	1
Ammonia (mg/1 N)*	5	1.6	1.0	2.8	0.71
Nitrite (mg/1 N)*	5	0.002	0.004	0.01	0.0
Nitrate (mg/1 N)*	5	0.026	0.042	0.10	0.0
Kjeldahl Nitrogen (mg/1 N)	5	2.2	1.7	4.3	0.72
NO_2 + NO_3 (mg/1 N)*	5	0.028	0.041	0.10	0.00
Orthophosphate (mg/1 PO_4)*	5	0.34	0.09	0.46	0.25
Phosphorous (mg/1)	5	0.15	0.04	0.19	0.09
Orthophosphorous (mg/1 P)*	5	0.11	0.03	0.15	0.08
Total Organic Carbon (mg/1)	5	23	27	57	3.1
Total Inorganic Carbon (mg/1)	2	0.0	0	0	0
Cyanide (mg/1)	-	-	-	-	-
Sulfide (mg/1)*	5	3.6	4.0	110	0.2
Hardness (mg/1 Ca, Mg)	5	49	60	120	33
Non Carbonate Hardness (mg/1)	5	0	0	0	0
Calcium (mg/1)*	5	4.2	4.1	9.3	0.7
Magnesium (mg/1)*	5	8.9	12	22	0.0
Sodium (mg/1)*	5	364	38	430	340
Sodium Adsorption Ratio	5	51	36	89	14
% Sodium	5	94	6.8	100	87
Potassium (mg/1)*	5	2.0	2.0	4.5	0.5
Chloride (mg/1)*	5	95	119	230	6.8
Sulfate (mg/1)*	5	38	40	86	3.5
Fluoride (mg/1)*	5	1.5	0.7	2.4	0.9
Silica (mg/1)*	5	12	4.4	18	8.1
Arsenic (mg/1)*	5	0.270	0.418	0.950	0
Barium (mg/1)*	7	0.105	0.066	0.200	0
Beryllium (mg/1)*	7	<0.005	0.005	<0.01	0
Bismuth (mg/1)*	5	<0.007	0.0008	<0.008	<0.006
Boron (mg/1)*	7	1.82	1.95	5.2	0.27
Cadmium (mg/1)*	7	0	0	0	0
Chromium (mg/1)*	7	<0.007	0.003	<0.010	0
Cobalt (mg/1)*	7	<0.004	0.003	<0.0008	0
Copper (mg/1)*	7	<0.002	0.0008	0.003	0.001
Iron (mg/1)*	7	0.064	0.025	0.110	0.040
Lead (mg/1)*	7	<0.003	0.004	<0.008	0.0
Manganese (mg/1)*	7	<0.008	0.008	0.020	0.0
Mercury (mg/1)*	5	<0.00006	0.00005	0.0001	0.0
Molybdenum (mg/1)*	7	0.065	0.085	0.200	0.0
Nickel (mg/1)*	7	<0.006	0.006	0.018	0.0
Silver (mg/1)*	7	<0.0001	0.0004	<0.001	0.0
Strontium (mg/1)*	7	2.03	2.50	5.20	0.05
Vanadium (mg/1)*	7	<0.003	0.003	<0.008	0.0
Zinc (mg/1)*	7	0.016	0.014	0.030	0.0
Tin (mg/1)*	5	<0.007	0.002	<0.011	<0.006
Aluminum (mg/1)*	7	0.039	0.047	0.130	0.0
Gallium (mg/1)*	5	<0.003	<0.0004	<0.004	<0.003
Germanium (mg/1)*	5	<0.008	0.002	<0.011	<0.006
Lithium (mg/1)*	7	0.360	0.320	0.77	0.060
Selenium (mg/1)*	5	0	0	0	0
Titanium (mg/1)*	5	<0.005	0.001	<0.007	<0.003
Zirconium (mg/1)*	5	<0.012	0.003	<0.016	<0.009
Gross Beta (pc/1 Cs_{137})*	5	<0.006	0.004	0.010	<0.0027
Chlorophyll A (mg/1)					
Chlorophyll B (mg/1)					
Phenols (mg/1)					
Dissolved Solids (mg/1)*	5	933	130	1090	826
Gross Alpha (mg/1 U)*	5	<0.013	0.003	<0.015	<0.0098
Gross Beta (pc/1 SR_{90}/Y_{90})*	5	<4.82	3.07	<8.2	<2.2

*Elements analyzed only for dissolved fraction

Some of the wide variation in bird's nest water quality may be explained by comparing the analyses of thieved (bailed) samples against pumped samples. The bird's nest water is typically charged with hydrogen sulfide gas (H_2S). Pumped samples were collected in a jar and exposed to the atmosphere. As the H_2S escaped under atmospheric pressure, the pH rose from 7.5 to 8.5 to more than 10.0. As the gas escaped and the pH rose, flocculation and precipitation occurred. This phenomenon must also occur in the borehole, which may explain the differences in water chemistry of thieved and pumped samples.

In Well P-3 and its companion Well, G-7, for example, a precipitate accumulates at the water surface. A continuous water level monitoring probe became firmly lodged in the casing after several months of successful operation. Each time Well P-3 is pumped, its recovery period becomes longer and the depth to which it recovers becomes deeper, suggesting a clogging of the aquifer. Last fall, a 2-in.-thick crust of white precipitate (presumably nahcolite) was observed in the stilling well at Station S-2, which is fed solely by effluent ground water during baseflow periods. In an effort to minimize the pumped waters' time of exposure to the atmosphere during sample collection, an in-line filter was used during the November-December 1975 pumped sample collection program. The unfiltered samples were collected directly from the discharge line. These data will not be available for reporting until the next quarter.

5. AQUIFER TEST PROGRAM

The aquifer test program was concluded in mid-September. The data have been analyzed by one or more analytical methods thought appropriate for the conditions in the field. Typically, the time-tested methods available and commonly used to interpret aquifer test data involve assumptions that may not be truly representative of the properties of the bird's nest aquifer. These assumptions are as follows:

1) The aquifer transmissivity is uniform in all directions far beyond the area impacted by pumping (isotropy)

2) Water is instantaneously released from storage

3) The discharging well penetrates and receives water from the entire thickness of the aquifer

4) Flow is laminar

The analytical methods looked at initially were those of R.E. Glover (unpublished, circa 1971), the Jacob (1950) modified non equilibrium formula, and the Theis (1935) recovery formula. The Jacob and Theis formulas were used, and the resulting data are shown in Table II-16.

Drawdown and recovery were monitored in the pumping wells and in two observation wells at each site. Other wells at distances as great as 1 1/2 mi from the sites were also monitored for drawdown and recovery. Pumping at each site continued beyond water level stabilization to insure that stabilization was not related to an isolated fracture or fracture system and was therefore temporary.

C. WORK SCHEDULED

1. SURFACE WATER

Monitoring will continue in accordance with the revised conditions of approval.

2. SURFACE WATER QUALITY

Sampling will continue according to schedule. The first annual baseline report will be prepared.

3. GROUND WATER LEVEL MONITORING

The continuous water level monitoring program will be modified next quarter by replacement of the currently used pressure transducers with float sensors and the Stevens punch tape recorders now in use.

4. GROUND WATER QUALITY

The existing alluvial ground water program will be augmented with the drilling of new wells at nine locations on and near the tracts. Wells will be completed with 2 to 5 ft of perforations at bedrock at all locations. If more than 15 ft of saturated alluvium is found at any location, a companion well will be completed nearby and will be

TABLE II-16

AQUIFER PUMP TEST RESULTS

	Observation Well Distance From Pumping Well(r) in ft.	Observation Well Designation	Method of Analysis	Period of Test	Calculated Aquifer Coefficients: Transmissibility (T) gallons/day/ft.	Calculated Aquifer Coefficients: Storage
P-1 Test Q = 45 gpm Duration of Pumping = 1800 min.	---	P-1 Pump	Time - Drawdown (Jacob)	Pumping	2475 (early slope)	---
					1458 (late slope)	---
	52.0	P-1 Pilot	Time - Drawdown (Jacob)	Pumping	914 (early slope)	3.35×10^{-4}
					1627 (late slope)	---
			Residual Drawdown	Recovery	972	---
			Calculated Recovery		1024	3.40×10^{-4}
	101.5	P-1 Core	Time - Drawdown (Jacob)	Pumping	1789	3.80×10^{-4}
			Residual Drawdown	Recovery	1584	---
P-2 Upper Test Q = 10 gpm Duration of Pumping = 1676 min.	48.0	P-2 Upper Pump	Time - Drawdown (Jacob)	Pumping	120 (early slope)	---
					27 (middle slope)	---
					15 (late slope)	---
		P-2 Upper Pilot	Time - Drawdown (Jacob)	Pumping	120 (early slope)	1.6×10^{-5}
					27 (middle slope)	---
					15 (late slope)	---
			Residual Drawdown	Recovery	25 (middle slope)	---
	98.0	P-2 Upper Core	Time- Drawdown (Jacob)	Pumping	123 (early slope)	1.07×10^{-5}
					36 (middle slope)	---
					17 (late slope)	---
			Residual Drawdown	Recovery	28 (middle slope)	---

TABLE II-16 (Cont.)

	Observation Well Distance From Pumping Well(r) in ft.	Observation Well Designation	Method of Analysis	Period of Test	Calculated Aquifer Coefficients: Transmissibility (T) gallons/day/ft.	Calculated Aquifer Coefficients: Storage
		P-2 Lower Pump		Pumping	---	---
				Recovery	---	---
P-2 Lower Test Q = 550 gpm Duration of Pumping = 8765 min.	48.6	P-2 Lower Pilot	Time - Drawdown (Jacob)	Pumping	62,586 (early slope)	6.77×10^{-6}
					111,692 (late slope)	---
			Calculated Recovery	Recovery	69,173	1.14×10^{-5}
			Residual Drawdown		69,173	---
	94.9	P-2 Lower Core	Time - Drawdown (Jacob)	Pumping	63,130 (early slope)	8.29×10^{-5}
					103,714 (late slope)	---
			Calculated Recovery	Recovery	68,514	3.13×10^{-5}
			Residual Drawdown		66,304	---
		P-2 Lower Core & Pilot	Distance - Drawdown	Pumping	69,339	1.68×10^{-4}
P-3 Test Q = 3 gpm Duration of Pumping = 30 min.		P-3 Pump	Time - Drawdown (Theis)	Pumping	58	0.105
			Time- Drawdown (Jacob)		61 (early slope)	0.085
					26 (late slope)	---
			Residual Drawdown	Recovery	6.7	---

perforated 2 to 5 ft beneath the existing water surface. Water levels will be measured monthly, and quality samples will be taken from all wells in January and June and from the deep wells only in April, May, July, and August, as specified by the AOSS. The samples will be analyzed according to an analytical schedule worked out by the AOSO and VTN.

5. AQUIFER TEST PROGRAM

No additional aquifer tests are expected.

III. AIR RESOURCES

A. WORK COMPLETED

During the quarter ending November 30, 1975, meteorology, air quality, radiation, and sound level monitoring continued as stipulated in the provisions of the leases or prescribed by the conditions of approval for the environmental baseline monitoring program. Certain additional supporting measurements were also made at the request of the lease operators.

Comprehensive calibrations of all air monitoring instruments were performed during the first part of September and again in the last two weeks of November. Measuring, both continuous and regular, continued on schedule.

Data from this quarter generally constitute a complete year of data collection, and thus some annual trends are apparent. A detailed discussion of such trends will appear in the First Year Environmental Baseline Report; a brief summary of some of these trends follows.

The data collected during the three months from August 1 through October 31, 1975, are tabulated in Table III-1, which shows the percentage of hours for each parameter during this period. Calibration time is counted as data collection time. Only those parameters specifically listed in the leases (or implied therein) are tabulated. The leases state that "the Lessee shall monitor air quality over at least 90 percent of each lease year, . . . using four strategically located stations (per tract)." Table III-1 shows that air quality was monitored 100 percent of the August-October period and that any given parameter was monitored at least 91 percent of the period. For meteorology, the leases state that "the Lessee shall establish a meteorological station . . . to monitor, at least 95 percent of the time over each lease year, . . ." various meteorological parameters. Again, meteorological monitoring was carried out for 100 percent of the August-October period at a number of stations, well in excess of the one station per tract specified in the leases, and each specified parameter was monitored 100 percent of the period.

TABLE III-1. Percentage of time monitoring was performed during the period 1 August - 31 October 1975.

Component	Number of Stations	Percentage
H_2S	8	100
SO_2	8	100
Susp. Part.	8	100
HC	3	91
NO_x	3	97
O_3	3	100
Wind (10 m)	12	100
Wind (20 m)	2	100
Wind (30 m)	2	100
Temp. (10 m)	7	100
Δ Temp. (30-10 m)	2	100
Rel. Hum. (10 m)	2	100

B. DATA SUMMARY

1. METEOROLOGY

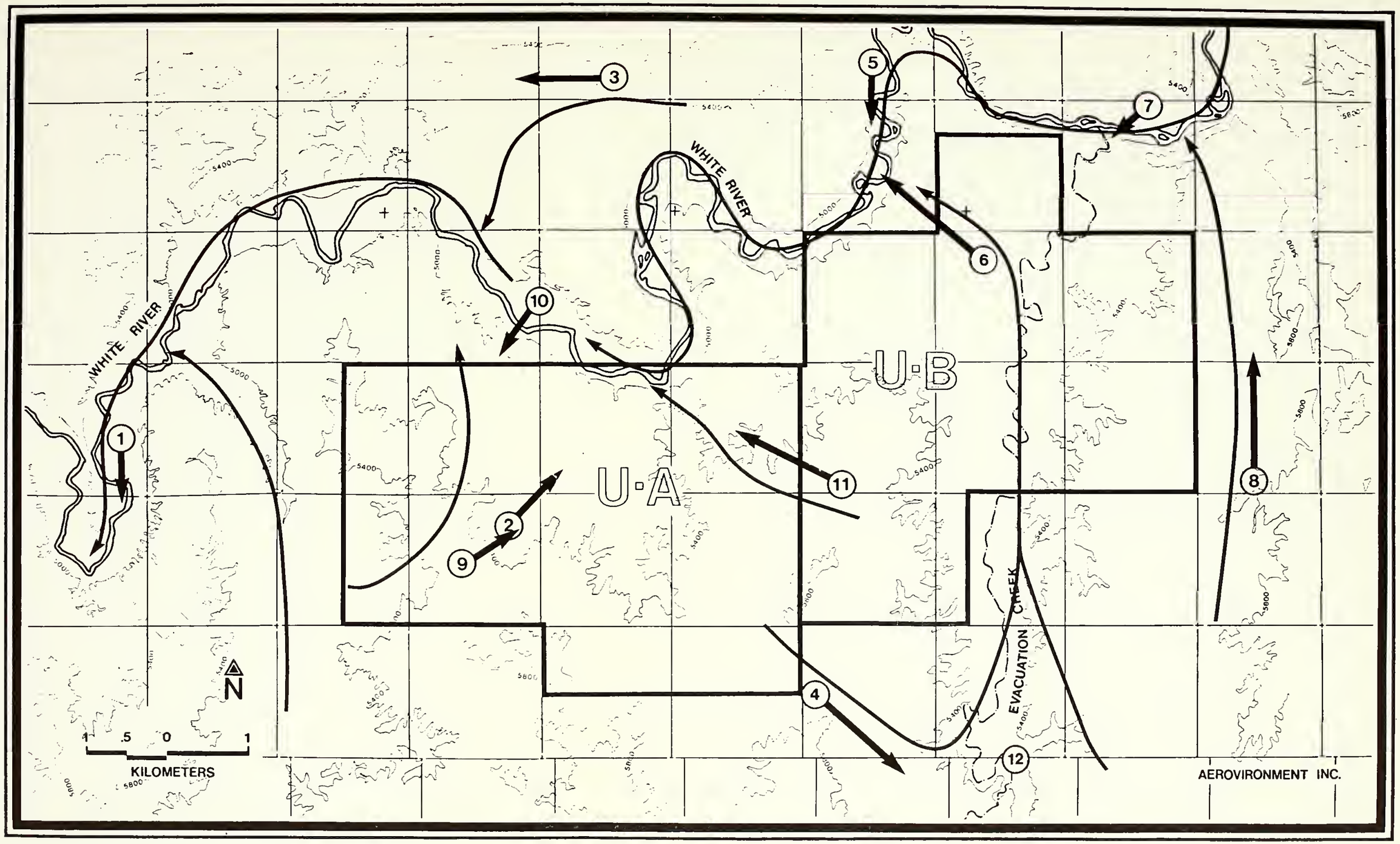
a. Surface Meteorology

The complicated pattern of surface airflow on the tracts has been repeatedly pointed out in earlier quarterly reports; surface airflow in the last quarter was no exception. Figures III-1 and III-2 depict typical early morning (0400-0700 MST) and afternoon (1400-1600 MST) airflows during October. The solid arrows in these figures represent wind vectors observed at the monitoring sites, and the dotted lines represent probable streamlines. In the early morning hours, as shown in Figure III-1, airflow was of the drainage type and strongly resembled the typical early-morning flow shown in previous reports. In the afternoon (Figure III-2) the flow was stronger and more organized but still complicated. The general air motion was from west to east. On Tract U-a, around Stations A-2 and A-9, winds were from the south to southwest. The return flow at Station A-4 was probably a localized phenomenon attributable to vertical motions induced by the complicated topography surrounding this location.

The diurnal variation of mean wind speed and its standard deviation at Station A-6 in October are plotted in Figure III-3. Wind speeds at night were considerably higher than those of previous quarters. The average was about 5 m/s (11 mph) at night, increasing to 6 m/s (13 mph) in the afternoon. During a few days of the month, average hourly wind speed readings were approximately 16 m/s (36 mph), and considerable dust was observed on the tracts. These high winds were associated with the passage of synoptic systems (cold fronts) and were the causes of the high values of the standard deviations presented in the figure.

The frequency distribution of wind speed and wind direction at Station A-6 in October is presented as a wind rose (Figure III-4), which shows that high winds generally came from the south. Forty-seven percent of all recorded readings were between 2.7 to 5.4 m/s (6 to 12 mph), and 38 percent of this category came from the southeast. During this month, only about 1 percent of all readings fell below 1.3 m/s (3 mph).

Figure III-5 presents the diurnal variations in temperature in October at Station A-6. Average nighttime values were

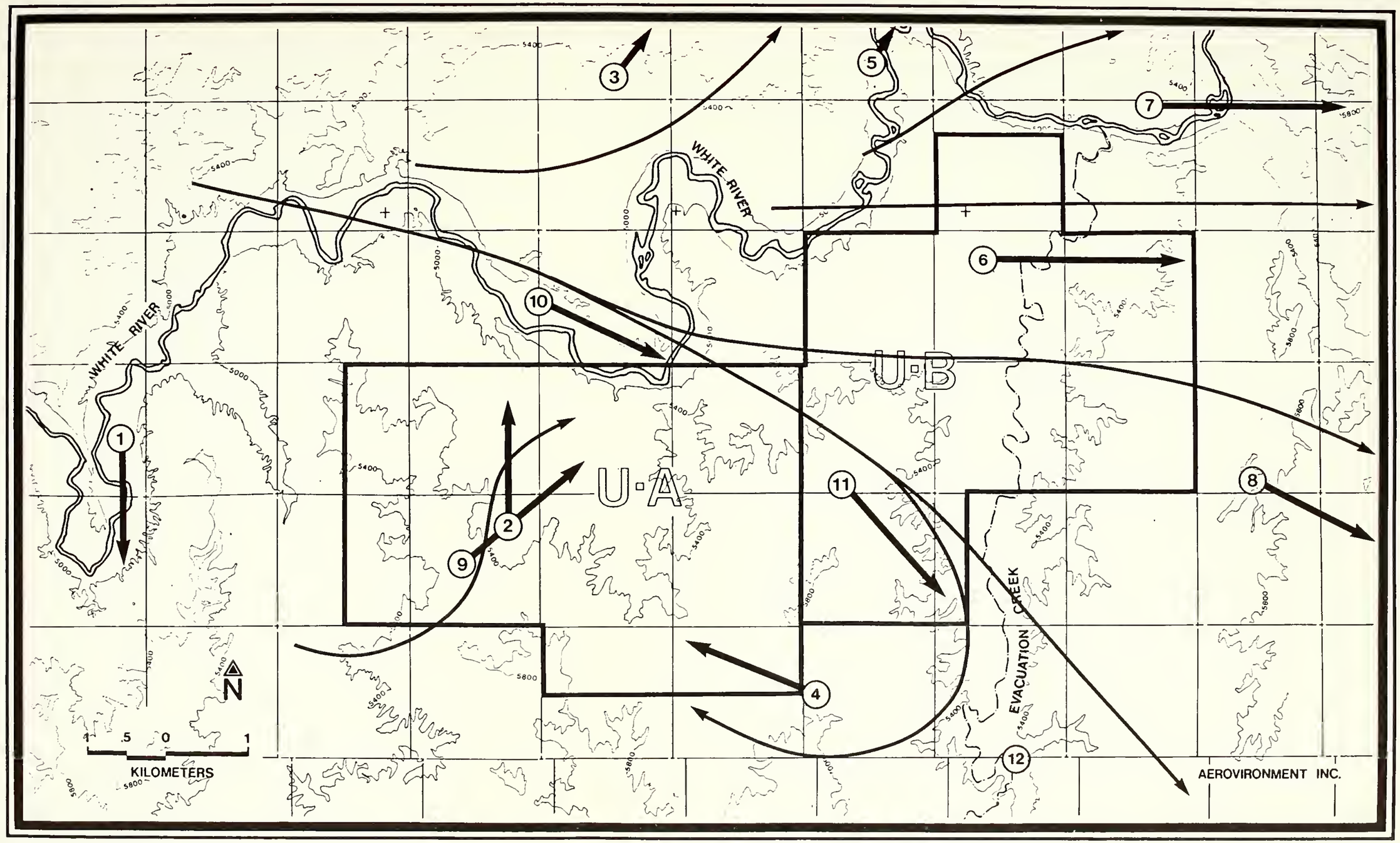


5 mps
Wind velocity and direction

Streamline

TYPICAL AIRFLOW PATTERN ON TRACTS U_a AND U_b
(IN THE MORNING IN OCTOBER 1975)

FIGURE III-1



5 mps
Wind velocity and direction

Streamline

TYPICAL AIRFLOW PATTERN ON TRACTS U_a AND U_b
(IN THE AFTERNOON IN OCTOBER 1975)

FIGURE III-2

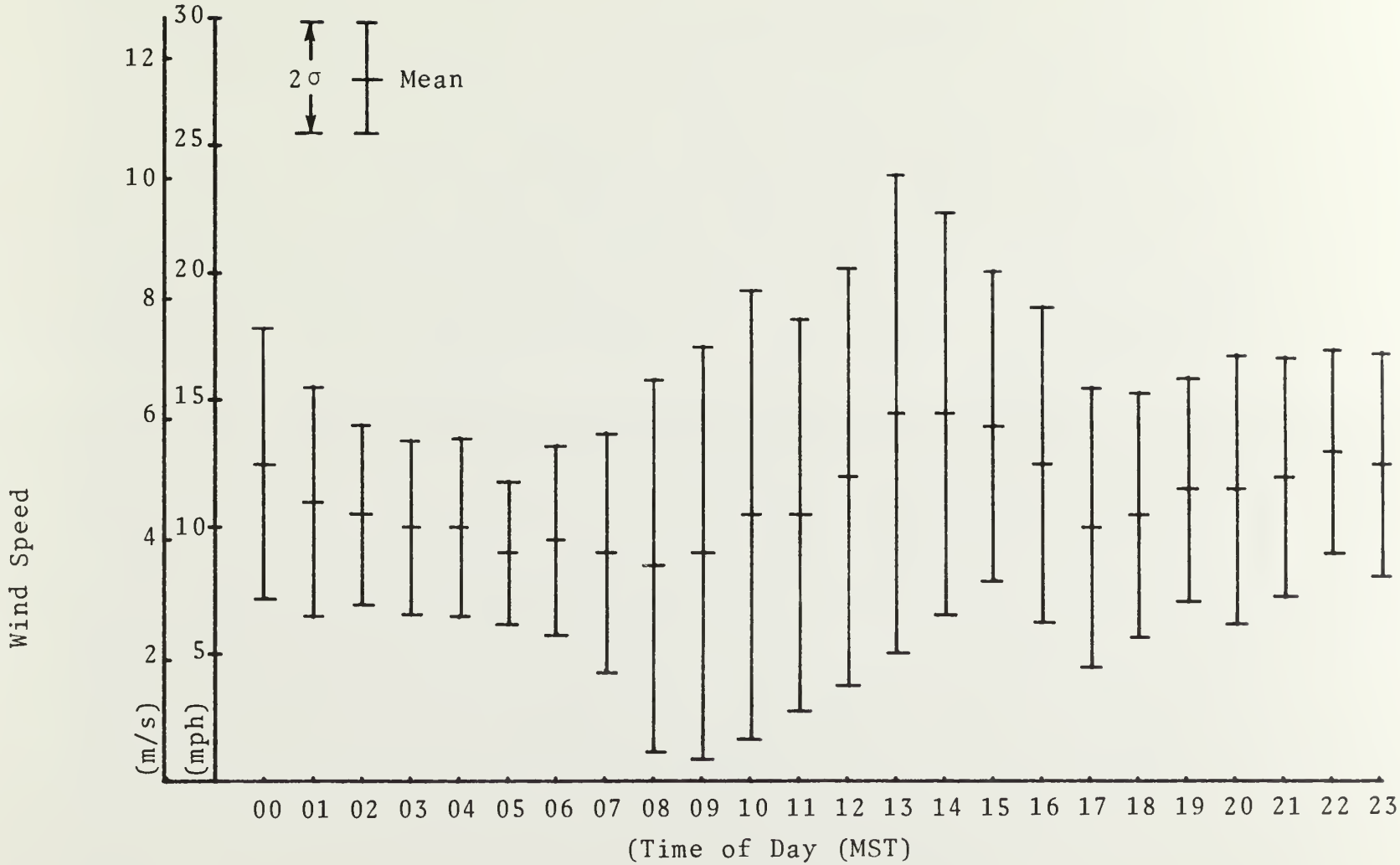


FIGURE III-3. Diurnal variation of mean wind speeds with their standard deviations at Station A6 during October.

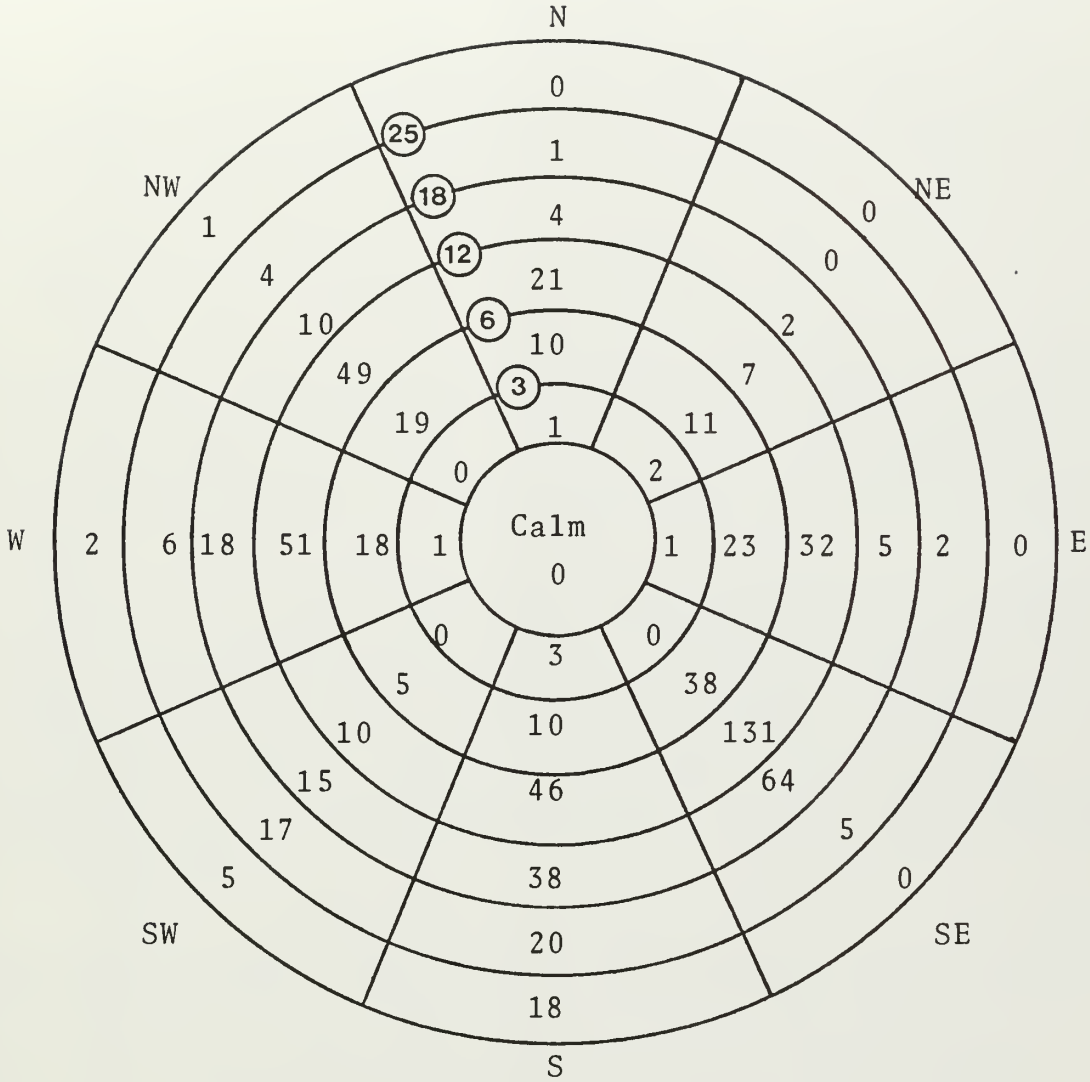


FIGURE III-4. Frequency distribution (in hours) of wind speed and direction at A6 in October. Circled numbers are wind speed readings in mph.

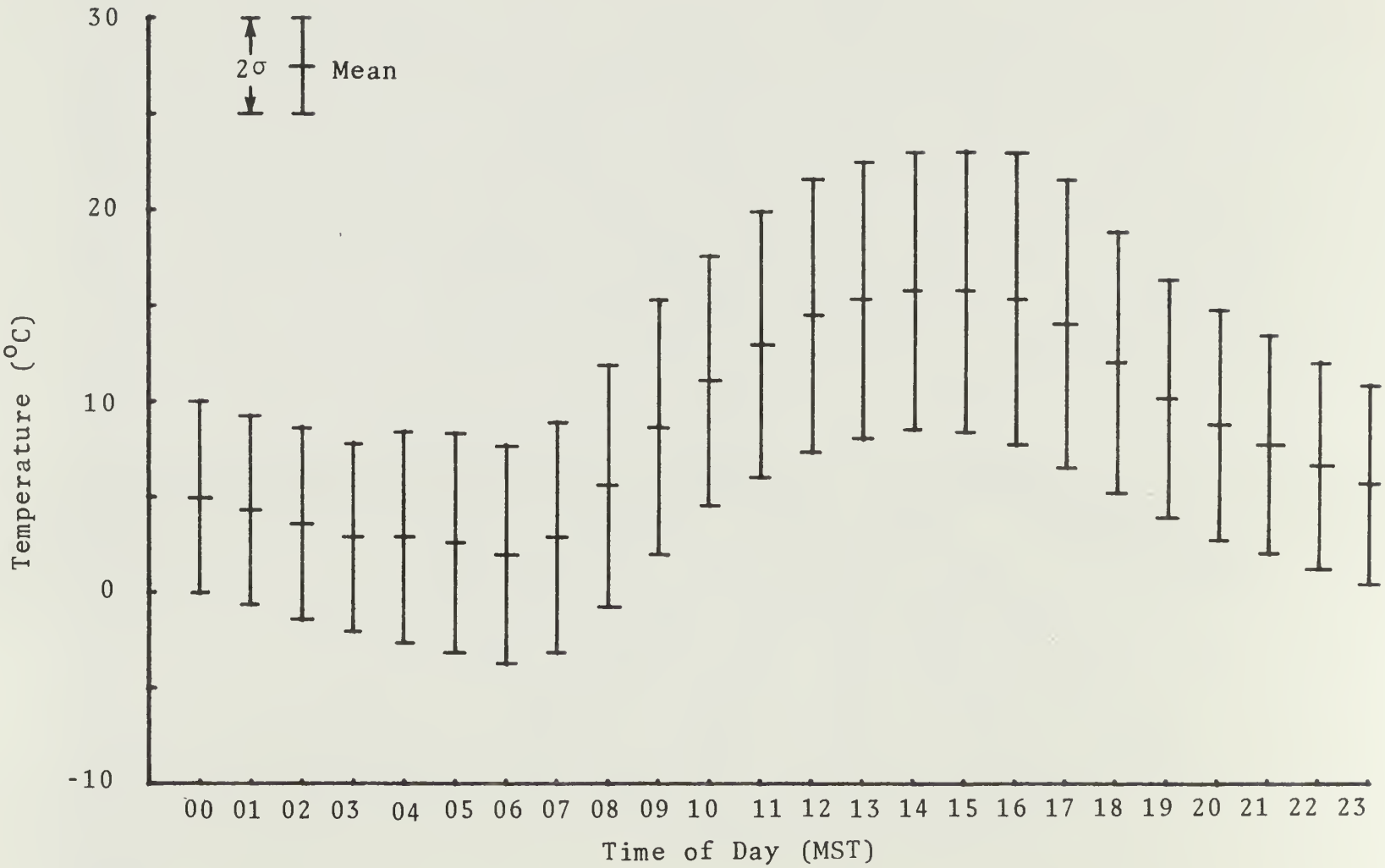


FIGURE III-5. Diurnal variation of mean temperatures and their standard deviations at Station A6 during October.

around 3°C, (37°F) and average afternoon values were around 16°C (61°F). The daily maximum temperature was generally observed between 1400-1500 MST, and the daily minimum temperature was observed between 0500-0600 MST. Throughout October 23 and 24, below-freezing temperatures were recorded at most recording stations. Below-freezing temperatures were also recorded on a number of other days during which high winds were also observed. The highest average hourly temperature reading was 27°C (81°F) at Station A-6 on the fifth, and the lowest average temperature reading was -19°C (2°F) at Station A-10 on the twenty-fifth.

b. Upper-Air Meteorology

Rawinsonde probing of upper-air temperature, relative humidity, and wind over Station A-6 occurs twice daily on every sixth day, with one release in the morning at dawn and one in the early afternoon. Continuous acoustic sounding of the bottom kilometer of the atmosphere also takes place at the same location.

For the entire study period to date, a surface-based inversion attributable to nocturnal cooling of the earth's surface has been generally observed in the morning and has usually disappeared in the afternoon. During October, the central month of this quarter, the average thickness of the surface-based inversion was about 411 m, varying between 70 and 701 m. This is the greatest average inversion depth observed during the baseline study. The strength of the inversion was about 2°C/100 m, ranging from 0.6°C/100 m to 3.6°C/100 m.

Early morning upper-air or subsidence inversions were common throughout October. Quite a few of these upper-air inversions lasted into the afternoon, although both their thickness and strength decreased. The average thickness was about 203 m, varying between 69 and 410 m. The strength was about 1°C/100 m, much weaker than the surface-based inversions.

Relative humidity in the lower kilometer above the ground was about 40 percent in the morning and about 35 percent in the afternoon. Winds in the first kilometer above the ground were usually from the west and southwest, with an average speed of about 2 to 4 m/s (4 to 9 mph) in the morning and afternoon.

Results of rawinsonde soundings on a typical fall day (October 21, 1975) are given in Figures III-6 and III-7. In the morning, a strong surface-based inversion extended to 200 m above ground level and was topped by a weaker inversion about 400 m thick. Above this was a slightly stable to neutral layer. Humidity in the first 400 m was around 40 percent. Winds were from the south, with speeds averaging about 2 m/s (4 mph) close to the ground surface, and from the west, averaging about 4 m/s (9 mph) above the first kilometer. The afternoon sounding showed a super-adiabatic layer about 55 m deep at ground level. The rest of the atmosphere was neutral or slightly stable. It was quite dry in the afternoon, with about 20 percent humidity throughout the lower atmosphere. Winds were from the west at speeds of about 3 m/s (7 mph).

c. Normality of Measurement Period

This section is an analysis of the normality of meteorological conditions on the tracts for April, May, and June 1975 using rawinsonde data collected by the National Weather Service at Grand Junction. Average wind speed, temperature, and humidity readings over 10 years (1964-1973) for each month of interest were calculated. These averages were obtained for standard significant pressure levels: surface (1,480 m, or 4,850 ft), 850 mb (approximately at the surface in Grand Junction), 700 mb (about 3,000 m or 10,000 ft), 500 mb (about 5,600 m or 18,300 ft) at 00Z (1700 MST), and 12Z (0500 MST). These averages were then compared with corresponding values for the same months in 1975.

In Figure III-8, the average wind speeds at 00Z (1700 MST) at significant pressure levels in April-June are compared with their 10-year averages. Figure III-9 shows a similar comparison of average wind speeds at 12Z (0500 MST), and Figures III-10 through III-13 present similar comparisons for humidity and temperature. There were only three 00Z observations at 850 mb during 1975, because surface pressure at Grand Junction happened to be less than 850 mb most of that time; thus, this comparison is excluded from the following discussion.

These comparisons show that the average temperature throughout the atmosphere during April and May was about 2°C lower than the 10-year averages, and that in June the temperature was about 1°C lower than the 10-year norm. At 12Z (0500 MST), humidity throughout the atmosphere during April and May was higher (about 10 percent) than normal. This implies that upper-air moisture in April and May 1975 was more abundant than usual. In April,

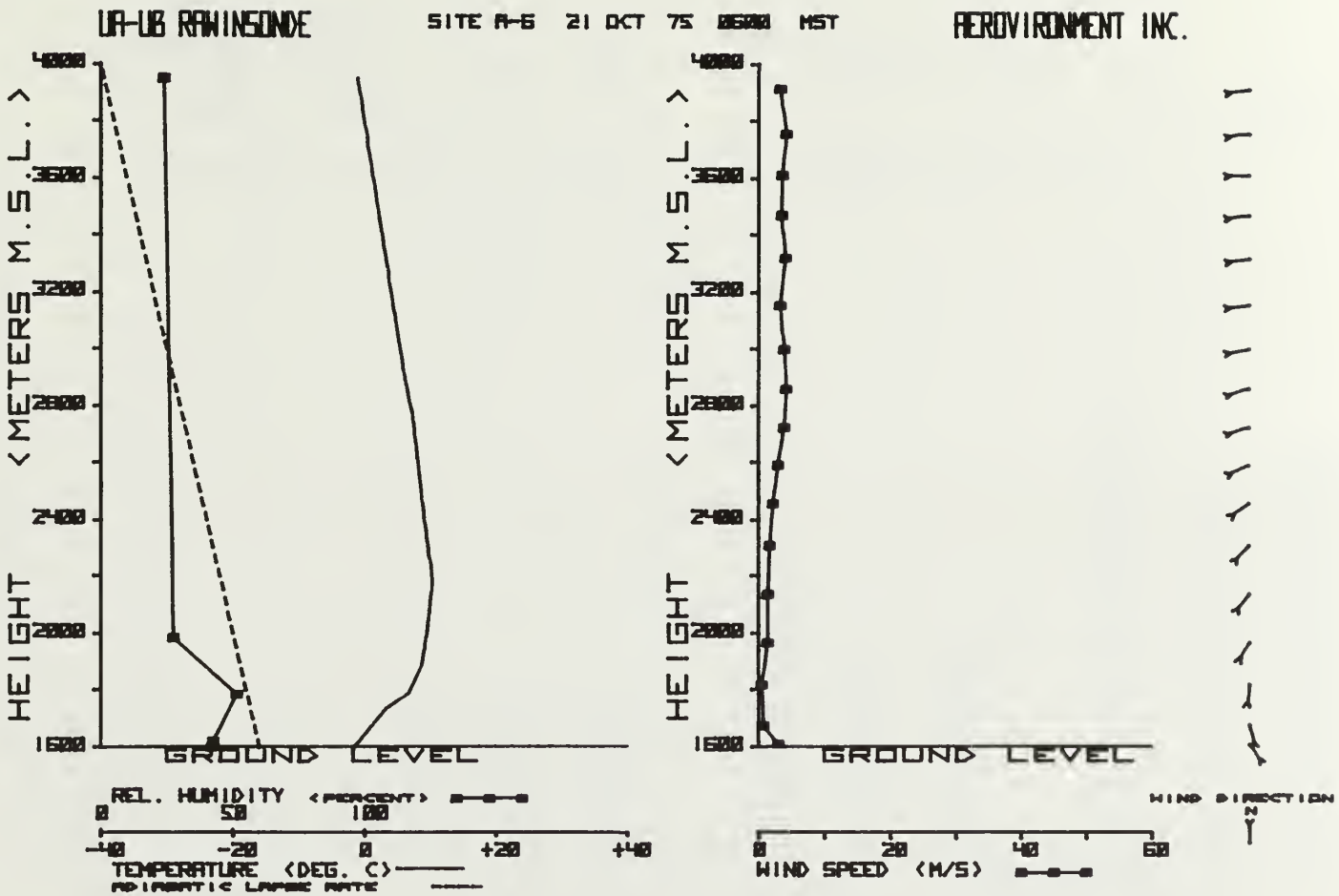


FIGURE III-6. Rawinsonde sounding at 0600 MST on 21 October at Station A6.

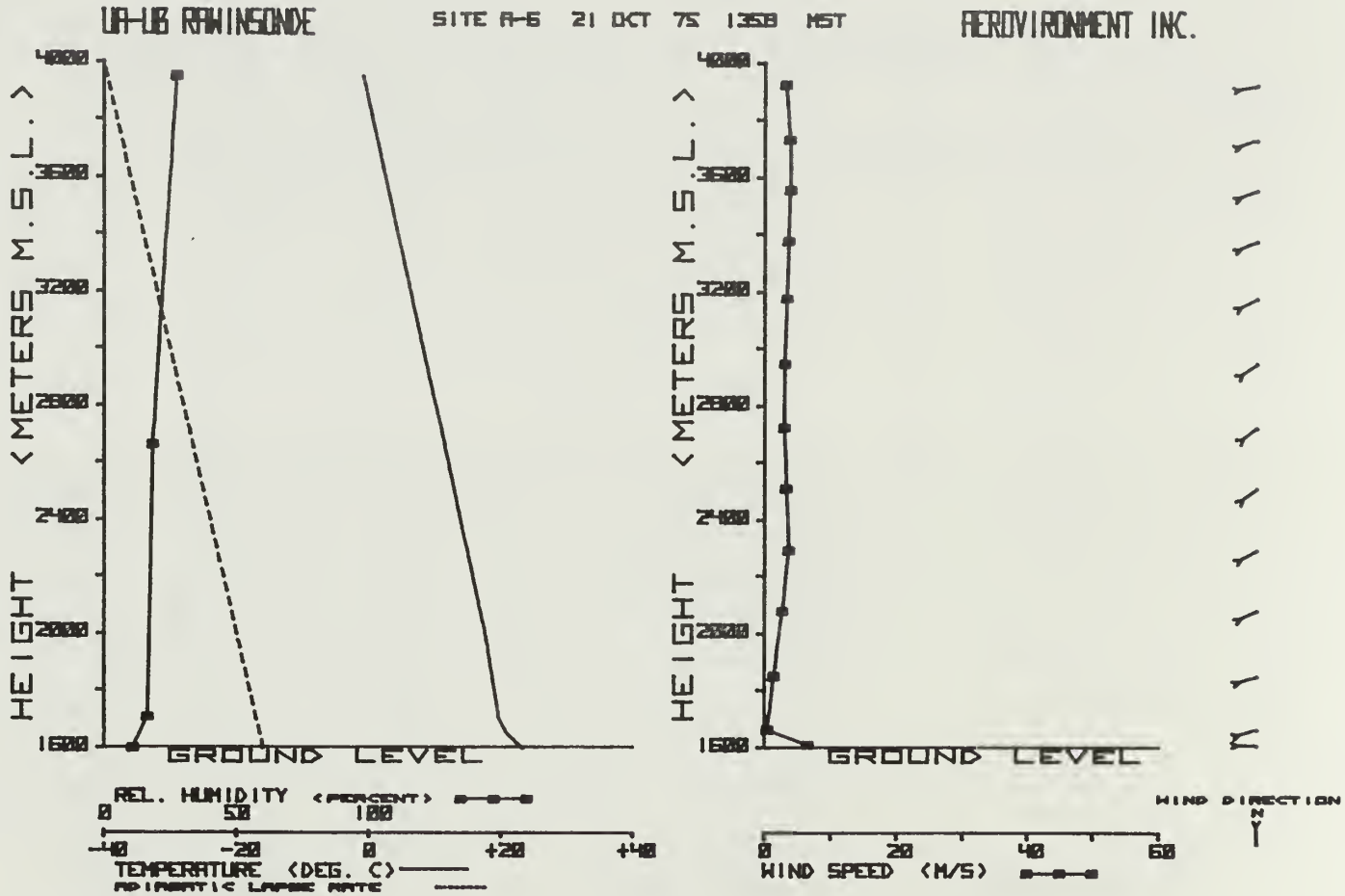


FIGURE III-7. Rawinsonde sounding at 1358 MST on 21 October at Station A6.

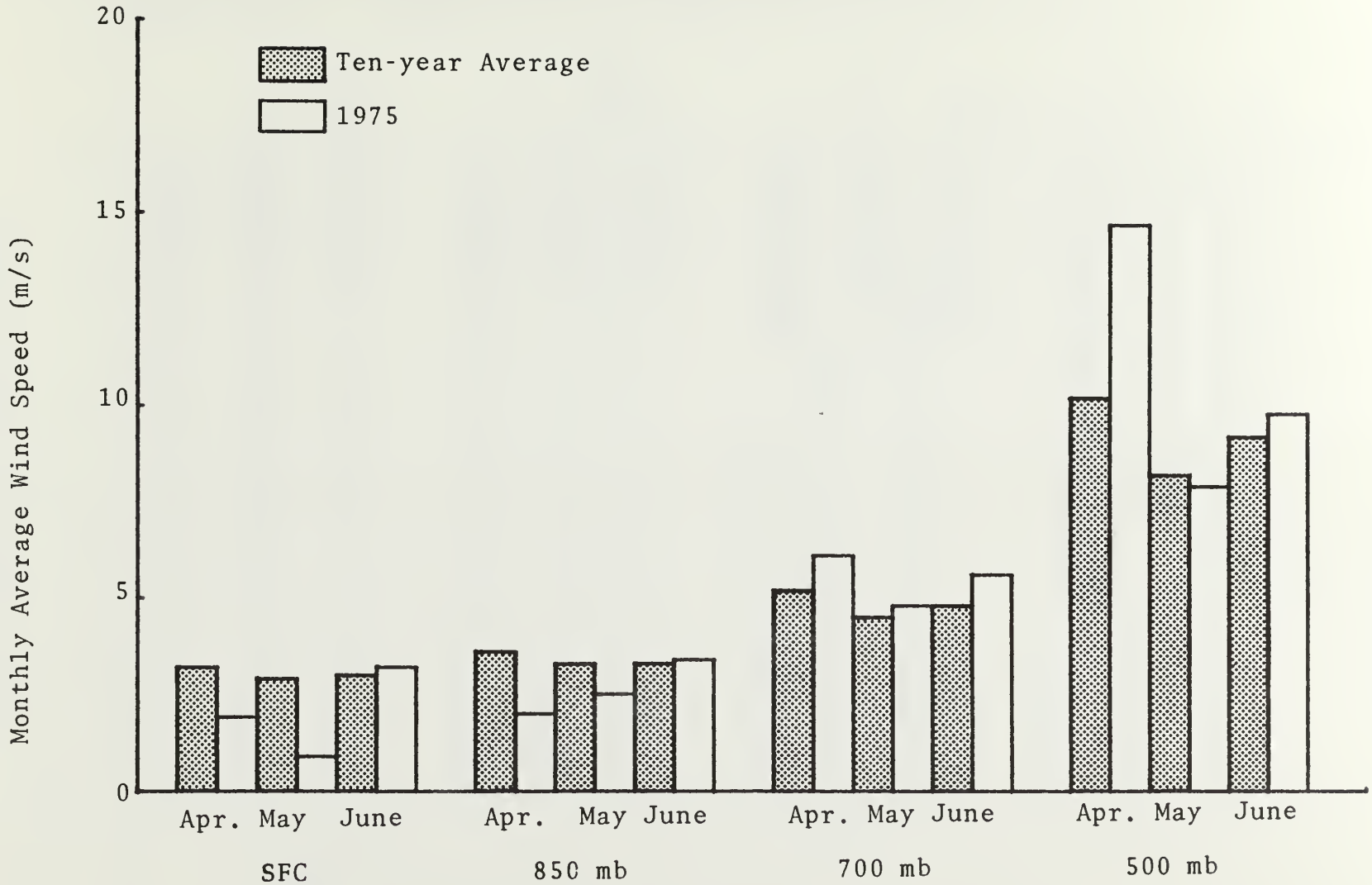


FIGURE III-8 . Normality of 00Z Grand Junction rawinsonde wind speed observations for the period April through June, 1975.

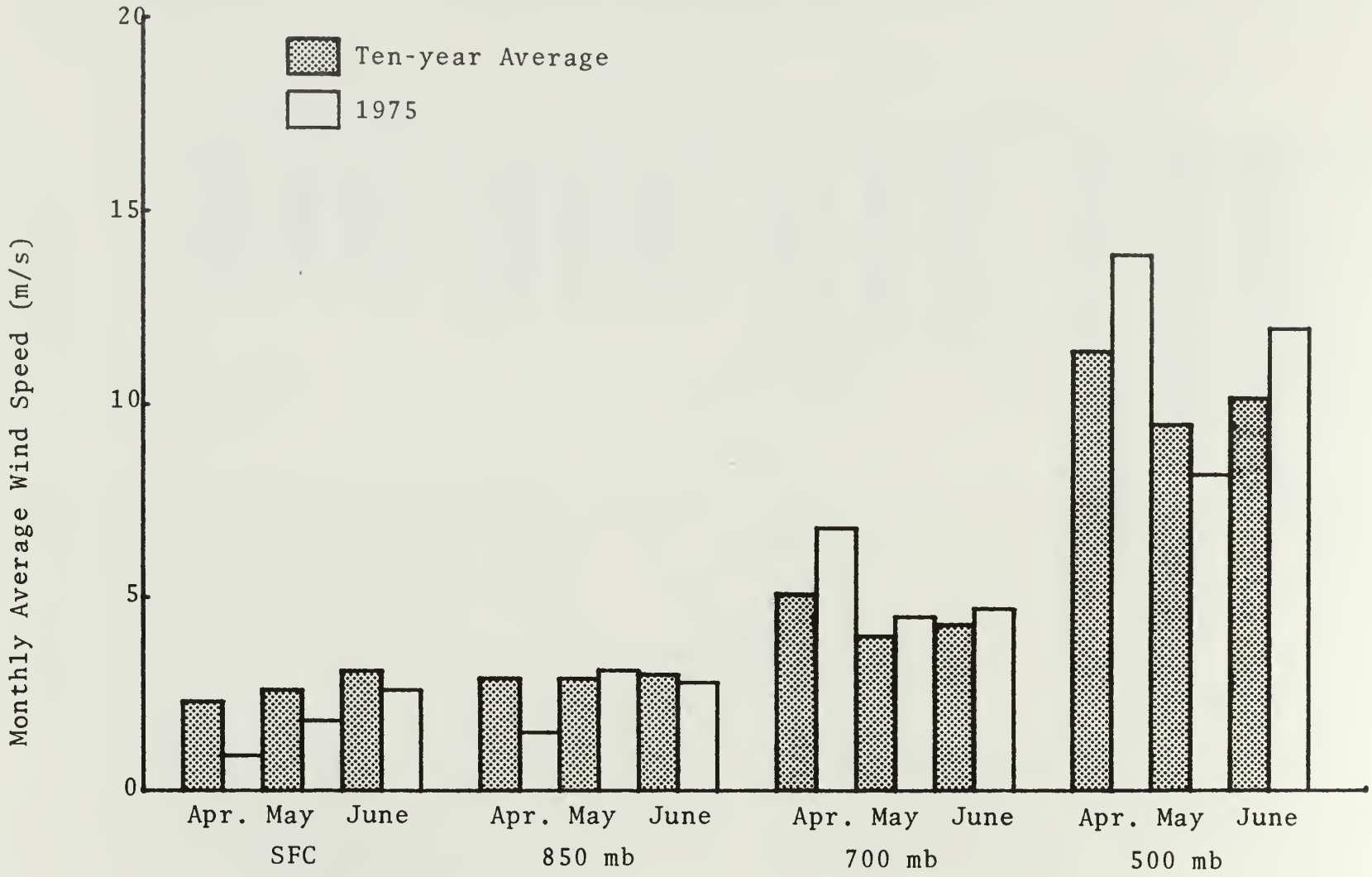


FIGURE III-9 . Normality of 12Z Grand Junction rawinsonde wind speed observations for the period April through June, 1975.

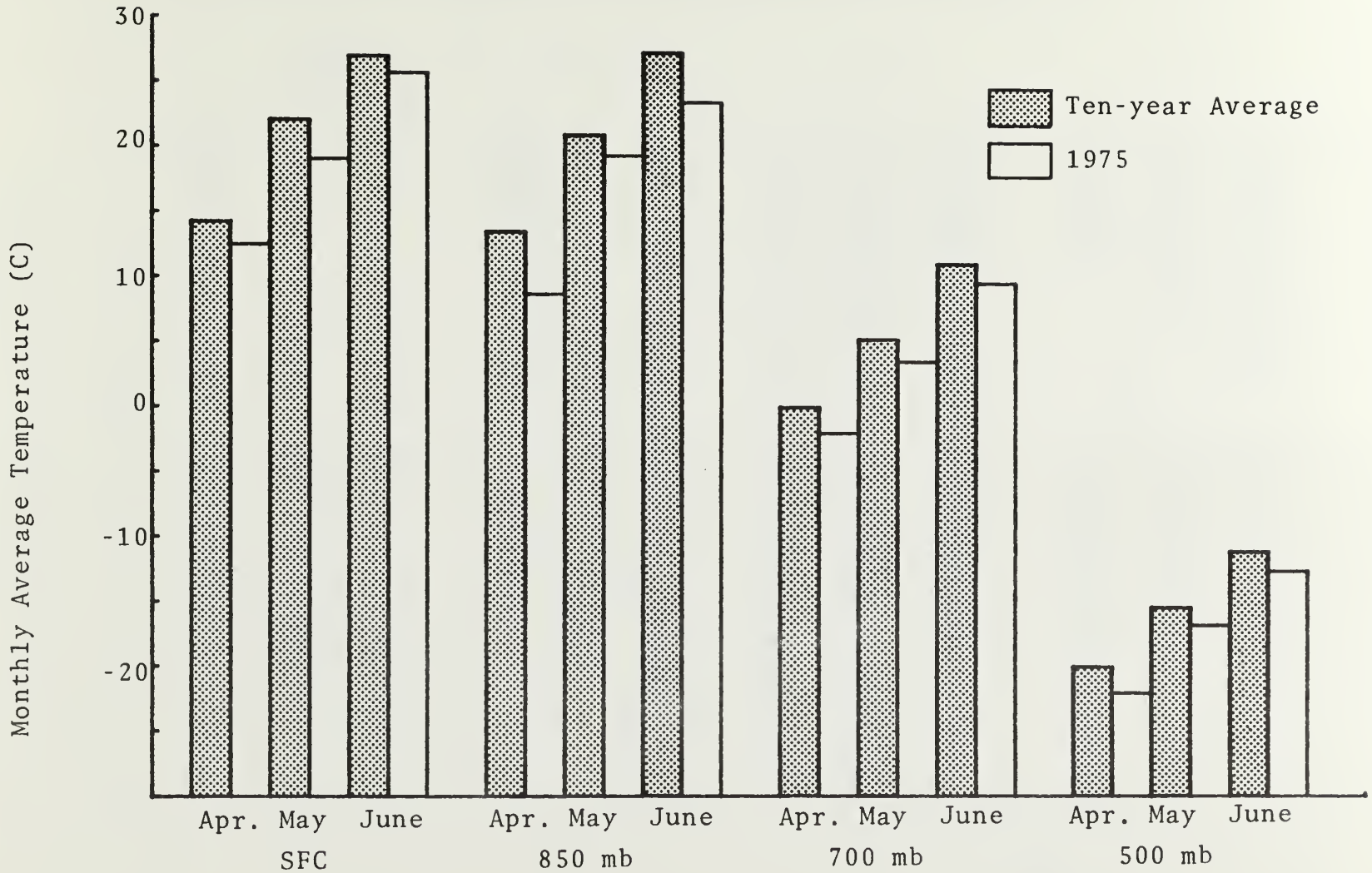


FIGURE III-10. Normality of 00Z Grand Junction rawinsonde temperature observations for the period April through June, 1975.

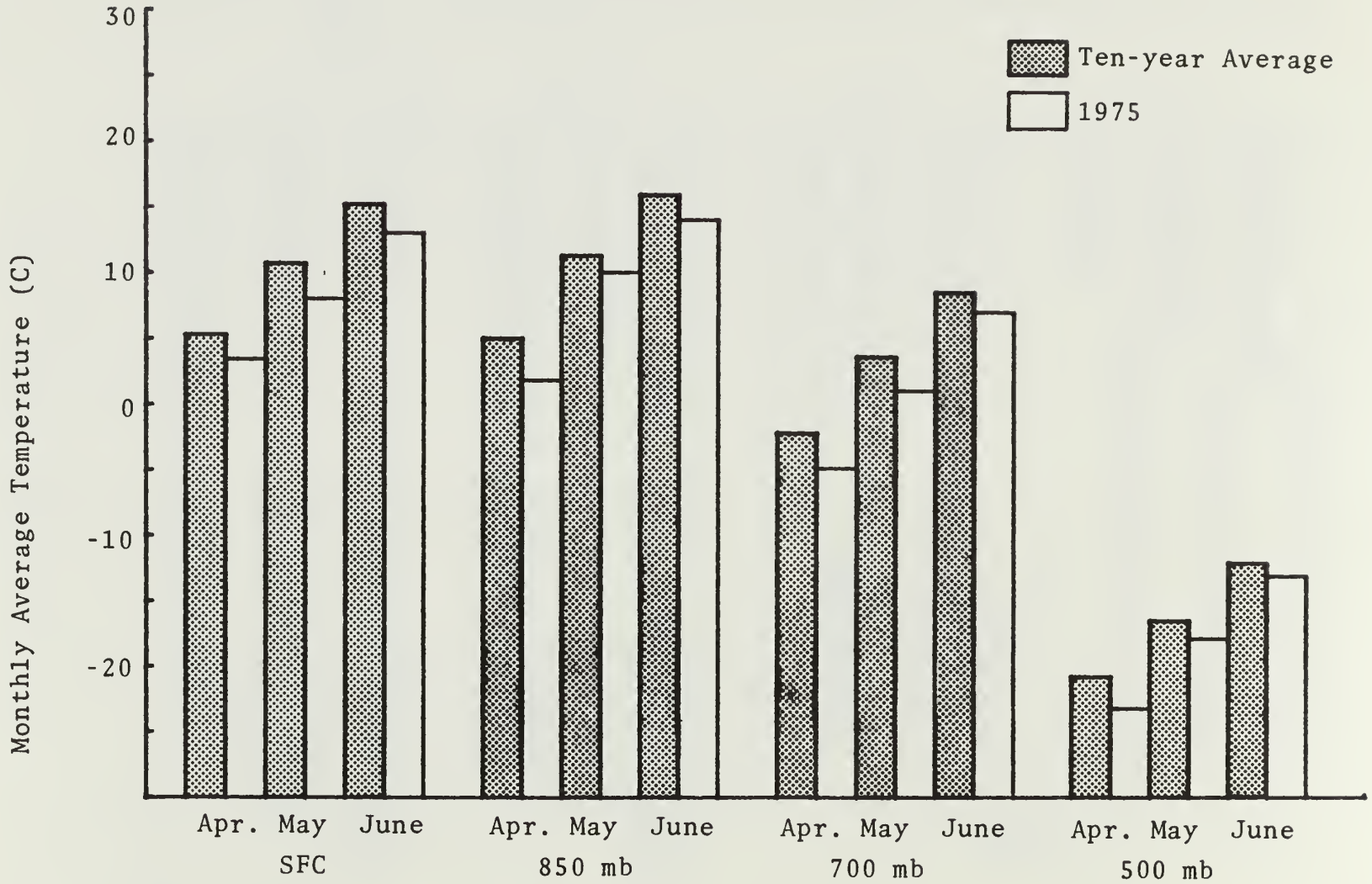


FIGURE III-11. Normality of 12Z Grand Junction rawinsonde temperature observations for the period April through June, 1975.

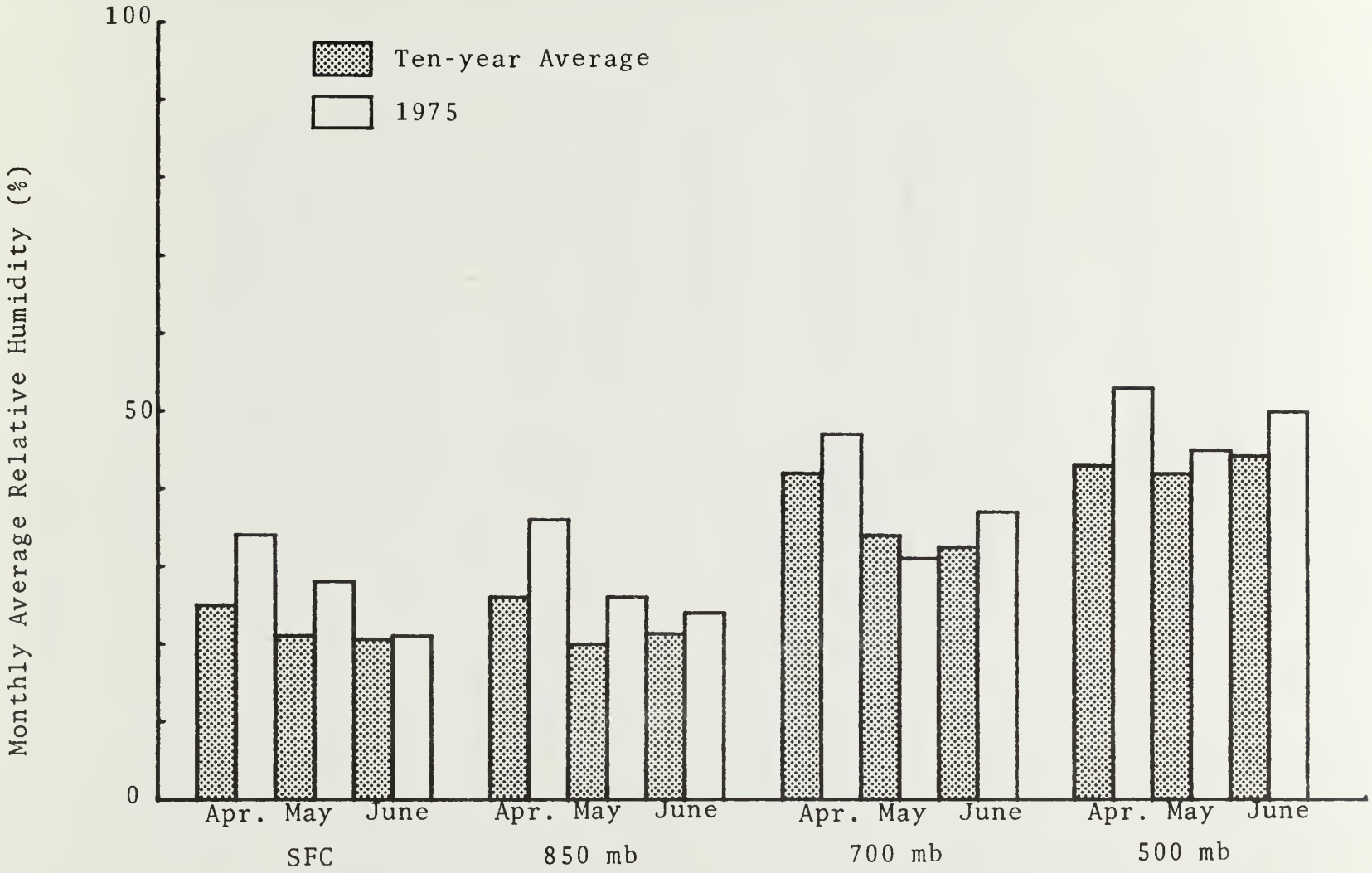


FIGURE III-12. Normality of 00Z Grand Junction rawinsonde humidity observations for the period April through June, 1975.

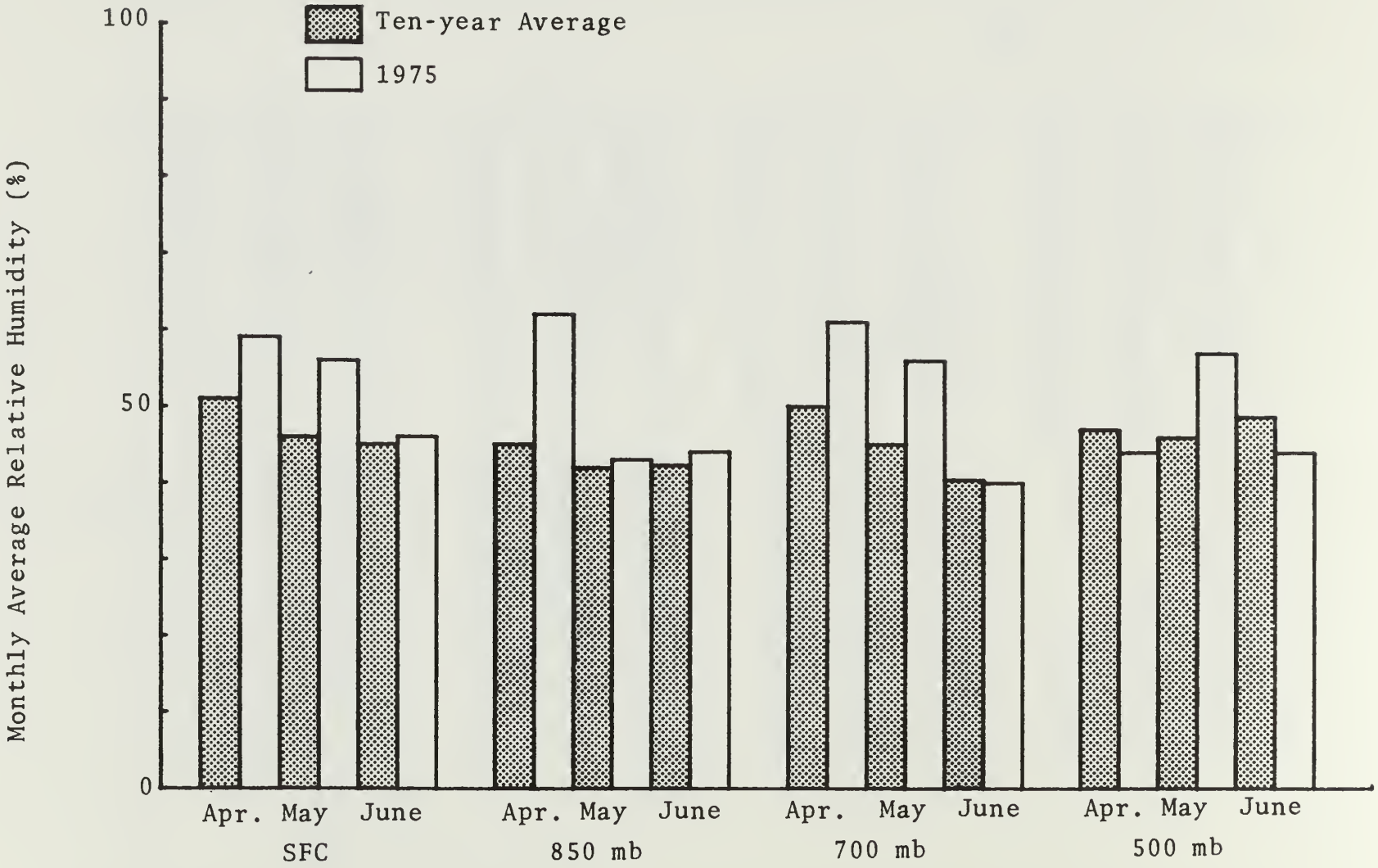


FIGURE III-13. Normality of 12Z Grand Junction rawinsonde humidity observations for the period April through June, 1975.

winds at 500 mb were about 2 to 4 m/s (4 to 9 mph) higher than the 10-year average. Values of other meteorological parameters were comparable to their 10-year averages. Thus, except for a higher than normal upper-air relative humidity during afternoon hours and a colder than usual temperature in the morning and afternoon in April and May, meteorological conditions in April through June at Grand Junction were normal; and by inference, the conditions on the tracts during this period should have been relatively representative of average conditions for these months.

2. DIFFUSIVITY

The dispersion or dilution of windborne effluents in the atmosphere boundary layer greatly depends on the turbulence intensity or the diffusivity of the atmosphere. On the tracts this diffusivity can be characterized by a number of routine meteorological measurements. One of these is the upper-air sounding. From the preceeding discussion of upper-air meteorology, it has been shown that during the last quarter, mixing in early morning hours was limited close to the ground by surface-based inversions, with an average strength of 2°C/100 m and an average depth of 400 m. In the afternoons, neutral or slightly stable atmospheric conditions usually prevailed.

Another approach to characterizing diffusivity is to compare temperatures at two surface stations in close proximity to each other but at different elevations. It was pointed out in the fourth quarterly report that qualitatively, comparing the temperatures of Stations A-6 and A-2 showed the proper trends over the 1610-1628 m altitude range and that comparing the temperatures of Stations A-6 and A-4 showed the proper trends over the 1610-1754 m range. Figure III-14 shows the average temperatures and their standard deviations in October at Stations A-2, A-4, and A-6 at 0500 and 1400 MST. The data are plotted against the height of the station to give a "sounding" of temperature. In the early morning hours the temperature at Station A-4 was higher than that at Stations A-2 and A-6, but in the afternoon all three temperatures were almost identical, which correlates with the existence of surface-based inversions in the morning and neutral conditions in the afternoon above Station A-6, as discussed earlier.

The dispersion of a plume is often described mathematically by the following diffusion equation.

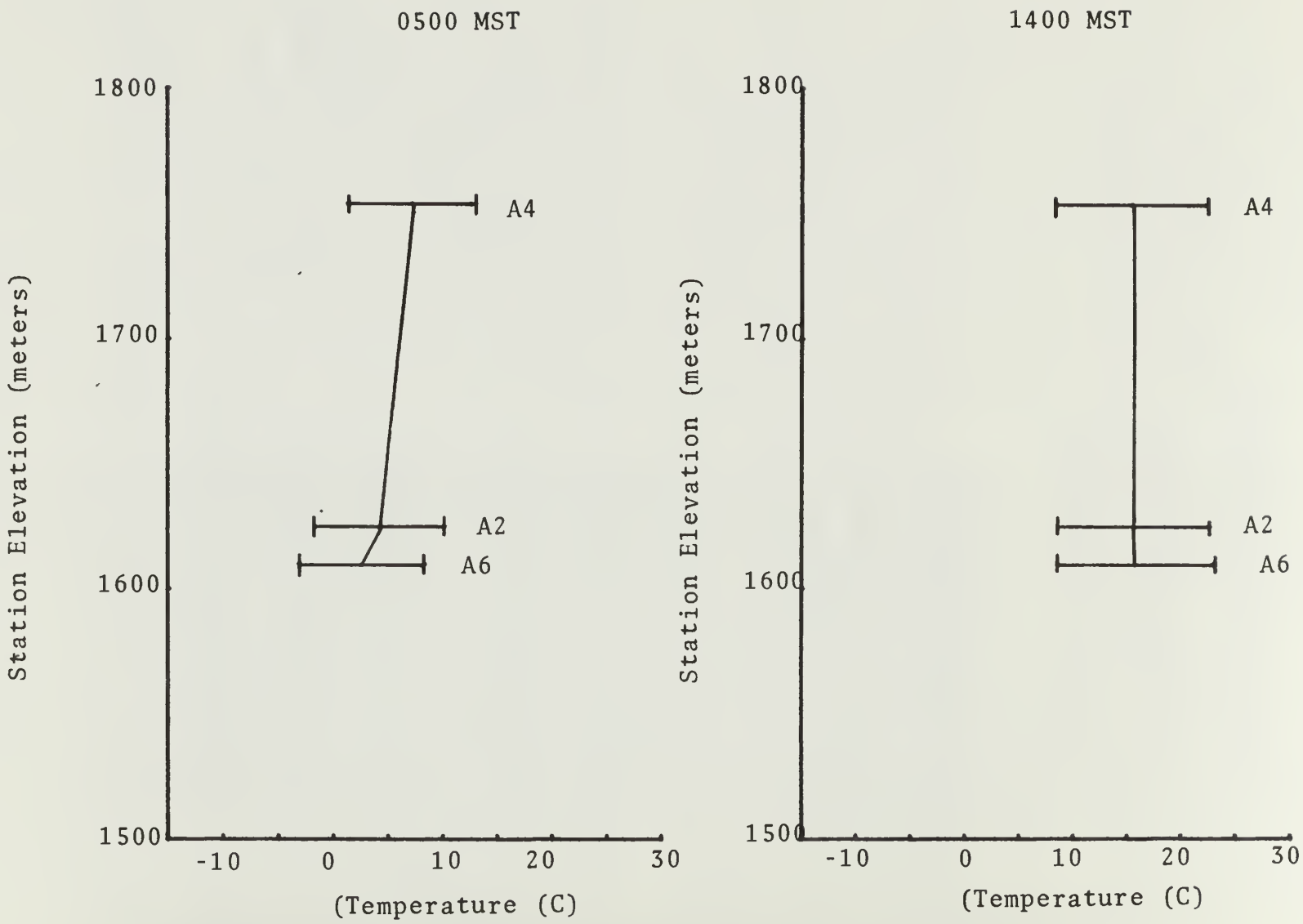


FIGURE III-14. Average October temperatures (0500 and 1400 MST) and standard deviations as function of station elevation.

$$\frac{X}{Q} = \frac{1}{\pi\sigma_y\sigma_z U} \exp \; -\frac{1}{2} \left(\frac{H}{\sigma_z} \right)^2$$

In this equation, X is the surface concentration; Q is the source emission rate; σ_y, σ_z are horizontal and vertical dispersion coefficients; U is the mean wind speed; and H is the effective stack height. MacCready et al. (1974) show that at downwind distances in excess of the order of a kilometer, $\sigma_y^2 \propto \sigma_v t$ and $\sigma_z^2 \propto \sigma_w t$ where σ_v and σ_w are the root-mean-square turbulent fluctuations in the lateral wind speed v, and the vertical wind speed w and t is the time of plume travel. Using these relationships for H = 0, and noting that the location of a receptor is given by x = Ut, the following equation can be derived.

$$\frac{X}{Q} \propto \frac{1}{(\sigma_v\sigma_w)^{1/2}\, x}.$$

This relationship, with H taken as zero, is valid along the centerline of a plume released aloft or at the surface for emissions released also at the surface (although ground effect makes the constant of proportionality twice as great in the latter case as in the former). For other cases the decay in X/Q with x is even greater because of the growth of σ_z in the exponential term.

As has been noted in previous quarterly reports, this then allows another approach to diffusivity characterization, since measurements of σ_v (or more precisely $\sigma_\theta = \sigma_v/U$) and σ_w are made continuously at Stations A-2, A-4, and A-6. Table III-2 presents the joint frequency distribution of $\sigma\theta$ and different wind speed categories at the 30-m tower at Station A-6 in October. The methodology for classifying the data into the common stability categories (labeled A-G) follows that recommended by Slade (1968).

These data show that for 71 percent of the time, when both $\sigma\theta$ and wind speed readings were available, the atmospheric condition was classified as neutral (stability class D) and that almost 50 percent of this condition was associated with moderate wind speeds of 2.7-5.4 m/s (6-12 mph). About 24 percent of the observations indicated diffusion equivalent to stable conditions (stability classes E-G) and about 6 percent, to unstable conditions (classes A-C).

Table III-3 gives a similar frequency distribution of σ_w versus wind speed for Station A-6 in October. This table shows that 55 percent of the time σ_w was between 0.20 to

WIND SPEED (MILES/HOUR)

Stability Class	$\sigma\theta$	>00-03	>03-06	>06-12	>12-18	>18-25	>25-35	>35	Total
A	23≤	0	0	0	0	0	0	0	0
B	18-<23	0	0	0	0	0	0	0	0
C	13-<18	0	3	12	4	3	2	0	24
D	8-<13	4	64	162	51	40	20	3	344
E	4-< 8	1	10	60	42	4	0	1	118
F	2-< 4	0	0	0	0	0	0	0	0
G	0-< 2	0	0	0	0	0	0	0	0
	Total	5	77	234	97	47	22	4	486

TABLE III-2. Frequency distribution of lateral turbulence ($\sigma\theta$) vs wind speed at Station A6 in October.

WIND SPEED (MILES/HOUR)

$\sigma\omega$ (m/s)	>00-03	>03-06	>06-12	>12-18	>18-25	>25-35	>35	Total
.80-<.	0	0	0	1	10	22	3	36
.65-<.80	0	1	13	6	21	0	0	41
.50-<.65	0	14	47	17	13	0	0	91
.35-<.50	0	20	42	36	9	0	0	107
.20-<.35	4	78	223	93	5	0	0	403
.10-<.20	4	21	21	3	0	0	0	49
-<.10	0	0	0	0	0	0	0	0
Total	8	134	346	156	58	22	3	727

TABLE III-3. Frequency distribution of vertical turbulence ($\sigma\theta$) vs wind speed at Station A6 in October.

0.25 m/s and that during that time the most predominant wind-speed category was that of 2.7 to 5.4 m/s (6 to 12 mph).

From such tables, by using the formulas given previously, joint frequency distributions of X/Q versus wind speed can be constructed for the tracts. Such data will be presented in the first year report for the baseline monitoring program.

3. AIR QUALITY

a. Gaseous Pollutants

Sulfur dioxide and H_2S are monitored at eight sites on the tracts. In addition, CO, HC, NO_2, and O_3 are monitored at three of the eight sites. There are no state air quality standards for gaseous pollutants, but federal standards exist for all components except H_2S. For reference in the ensuing discussion, Table III-4 presents the Federal Ambient Air Quality Standards (AAQS) for the various gaseous pollutants monitored on the tracts.

The air quality on the tracts has consistently been very good, which is expected because of their remote location. During this quarter, except for sporadic occurrences of high non-methane hydrocarbon (NMHC) readings, the air on the tracts was relatively free of gaseous pollutants. In fact, almost all instruments were recording at their threshold limit most of the time, except that ozone values were measureable but did not exceed standards.

On October 12 the NMHC reading at Station A-6 between 6 a.m. and 9 a.m. averaged 300 $\mu g/m^3$ (0.46 ppm); NMHC standards were also exceeded on several days at Station A-3. It should be noted that the federal standard of 160 $\mu g/m^3$ (0.24 ppm) for the 3-hour period from 6 a.m. to 9 a.m. was established to reduce the formation of photochemical pollutants (for which separate standards exist also) and not as a health standard per se. Exceeding of NMHC standards in unpopulated areas are frequently observed throughout the United States, so the levels on the tracts are not unusual.

For ozone, the only measureable gaseous pollutant during this quarter, the peak hour and average values and the percentage of observations exceeding federal AAQS at each site are tabulated in Table III-5. The highest hourly average recorded on the tracts was 140 $\mu g/m^3$ (0.07 ppm). The average value on the tracts was about 75 $\mu g/m^3$ (0.04

TABLE III-4. Federal air quality standards for gaseous pollutants.

Pollutant	Averaging Time	Primary Standards	Secondary Standards
Ozone (O_3)	1 hour	160 $\mu g/m^3$ (0.08 ppm)	same as primary
Carbon Monoxide (CO)	8 hours	10 mg/m^3 (9 ppm)	same as primary
	1 hour	40 mg/m^3 (35 ppm)	same as primary
Sulfur Dioxide (SO_2)	Annual Average	80 $\mu g/m^3$ (0.03 ppm)	-
	24 hour	365 $\mu g/m^3$ (0.14 ppm)	-
	3 hour	-	1300 $\mu g/m^3$ (0.5 ppm)
Nitrogen Dioxide (NO_2)	Annual Average	100 $\mu g/m^3$ (0.05 ppm)	same as primary
Hydrocarbons (corrected for methane) (NMHC)	3 hour (6-9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	same as primary

TABLE III-5. Peak and average hourly values of ozone ($\mu g/m^3$), the number of hourly observations and percentage of observations exceeding standards in central month (October) of the quarter at Stations A2, A3, and A6.

Station	Peak Value	Average Value	Number of Observations	% of Observations Exceeding Standards
A2	120	70	719	0
A3	140	100	519	0
A6	110	60	721	0

ppm), which is well below the standard and within the typical global background range of 40 to 100 $\mu g/m^3$.

A plot of diurnal variations in ozone concentrations at Station A-2 in October is presented in Figure III-15. The average diurnal trend consisted of low readings of about 50 $\mu g/m^3$ (0.03 ppm) between 0300 and 0800 in the early morning hours and higher values of 80 $\mu g/m^3$ (0.04 ppm) between 1200 and 1600 in the afternoon.

Table III-6 presents the highest and the average values for other gaseous pollutants at Stations A-1 through A-8 in this quarter. Very little diurnal variation was observed for any of these pollutants. Furthermore, the measured values were very low, near the detection threshold of the instruments, and all well below any applicable standards. In general, the H_2S and SO_2 variations are simply due to variability in instrument responses near their detection thresholds.

The relative frequency distributions of pollutant concentrations of CO, SO_2, H_2S, NO_2, and O_3 observed in October (the fall quarter) at Station A-2 are given in Table III-7. Since station-to-station variability has been low, data presented in this table are representative of the general air quality on both Tracts U-a and U-b.

b. Particulates and Trace Metals

Particulate concentrations on the tracts are monitored by high volume samplers that sample simultaneously over a period of 24 hours once every six days at all eight air-monitoring sites. The sizes of particulates collected by the samplers range from below 1 μm to somewhat above 25 μm.

Table III-8 presents the geometric mean, standard geometric deviation, maximum, and minimum of particulate concentrations in $\mu g/m^3$ at all sites in the fall quarter. Data collected between September 1 and November 30 were used. Because particulate concentrations have been found to be lognormally distributed in general, the geometric mean presented can be considered to correspond to the maximum concentration to be expected at a 50 percent frequency.

The geometric mean of particulate concentrations ranged from 9.5 $\mu g/m^3$ at Station A-1 to 31.2 $\mu g/m^3$ at Station A-5. There was noticeable spatial variation on the tracts. Station A-5, on the west bank of the White River and about 1/8 mile west of the main dirt road linking Bonanza and

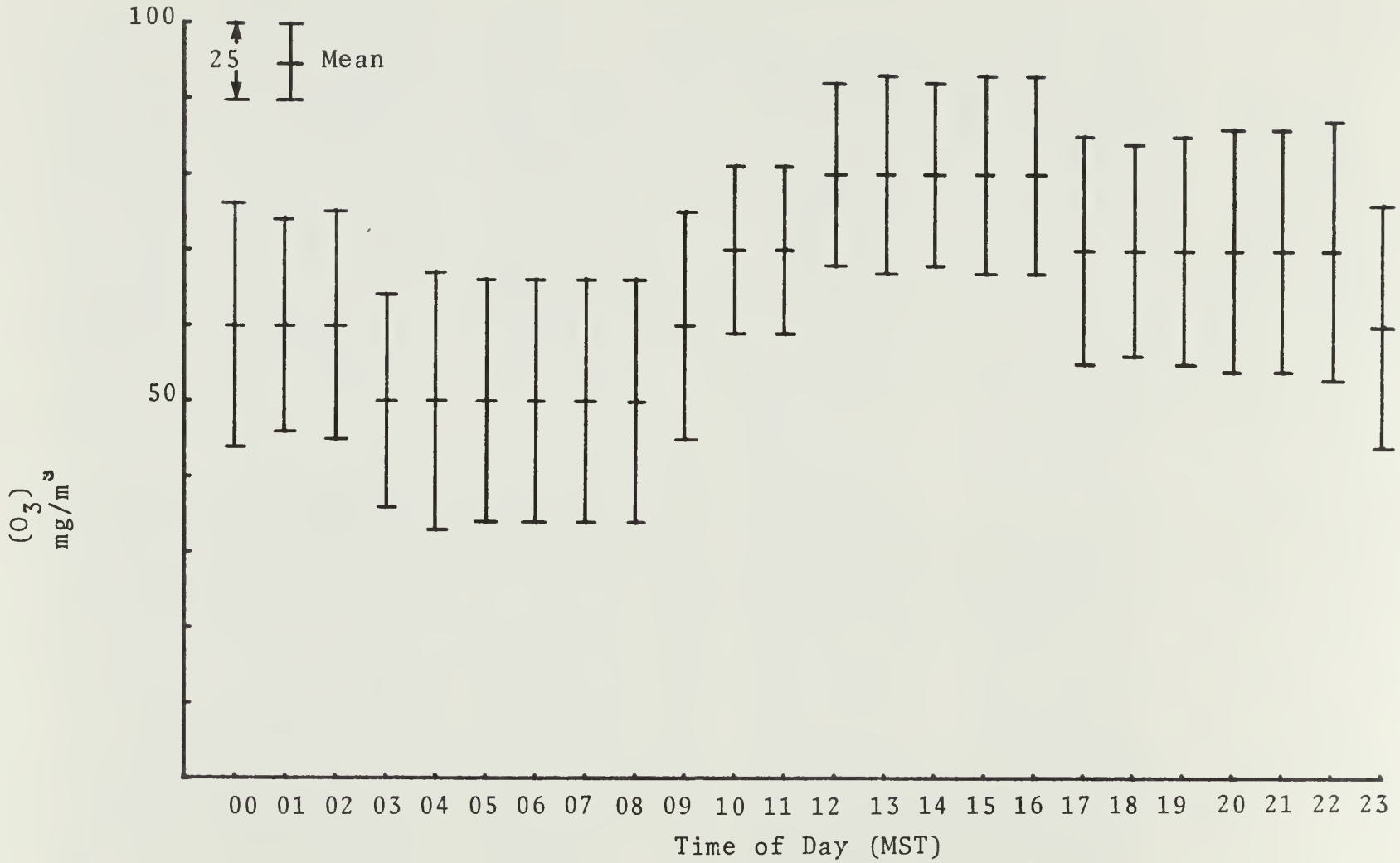


FIGURE III-15. Diurnal variation in mean ozone concentrations with their standard deviations at Station A2 during autumn, based on data for the central month of the quarter.

TABLE III-6. The highest and average value of SO_2, H_2S, CO, and NO_2 measured at Station A1-A8 during the fall Quarter (based on October data).

Pollutant	Station	Peak	Average
SO_2 ($\mu g/m^3$)	A1	25	0
	A2	0	0
	A3	-	-
	A4	10	0
	A5	0	0
	A6	5	0
	A7	10	5
	A8	10	5
H_2S ($\mu g/m^3$)	A1	5	0
	A2	0	0
	A3	-	-
	A4	10	0
	A5	0	0
	A6	10	0
	A7	5	0
	A8	5	0
CO (mg/m^3)	A2	.5	.2
	A3*	1.2	.2
	A6	1.2	.3
NO_2 ($\mu g/m^3$)	A2	20	0
	A3	10	0
	A6	20	0

* Based on 83 observations.

Notes

(1) The Tracor analyzer at Station A3 was out of order during most of October.

(2) Nominal detection limit for instrumentation on the tracts is:

SO_2 - 13 $\mu g/m^3$ (0.005 ppm) CO - 0.1 mg/m^3 (0.1 ppm)

H_2S - 7 $\mu g/m^3$ (0.005 ppm) NO_2 - 10 $\mu g/m^3$ (0.005 ppm)

Values below the detection limits have no significance.

TABLE III-7. Relative frequency distribution (%) of concentrations of CO, O_3, NO_2, SO_2, and H_2S at A2 in Fall using the central month of the quarter as a representative sample. Values to the right of the double line exceed a short-term Federal Ambient Air Quality Standard.

CO (mg/m^3)

Conc.	0-1.9	2.0-3.9	4.0-5.9	6.0-10.0	> 10.0
Relative Frequency	100	0	0	0	0

O_3 ($\mu g/m^3$)

Conc.	0-59	60-99	100-129	130-160	> 160
Relative Frequency	37	59	4	0	0

NO_2 ($\mu g/m^3$)

Conc.	0-24	25-49	50-74	75-100	> 100
Relative Frequency	100	0	0	0	0

H_2S ($\mu g/m^3$)

Conc.	0-12	13-22	23-32	33-42	> 42
Relative Frequency	100	0	0	0	0

SO_2 ($\mu g/m^3$)

Conc.	0-15	16-20	31-99	100-365	> 365
Relative Frequency	100	0	0	0	0

TABLE III-8. The geometric mean, standard geometric deviation, maximum and minimum of particulate concentrations ($\mu g/m^3$) at Stations A1-A8 in the fall quarter (1 September through 30 November).

Station	Geo. Mean	Standard Geo. Dev.	Maximum	Minimum
A1	9.5	1.8	31.1	4.6
A2	10.7	2.0	29.6	3.3
A3	11.3	1.8	29.2	5.2
A4	17.2	1.8	47.1	4.0
A5	31.2	2.3	127.4	8.6
A6	17.2	2.1	52.8	4.9
A7	11.1	1.7	26.8	3.9
A8	18.6	2.0	49.7	7.9

the tracts, was the dirtiest station with respect to particulates. It was followed by Stations A-4, A-6, and A-8. The day with the highest particulate levels was October 21, when all sites registered higher than 20 $\mu g/m^3$. On that day a value of 127.4 $\mu g/m^3$ was measured at Station A-5. Particulate concentrations were relatively lower in November, attributable to the appearance of snow cover on the ground surface.

None of the recorded values exceeded federal or state standards, which are presented in Table III-9. The most stringent short-term standard is the National Secondary Standard, which sets the upper limit at 150 $\mu g/m^3$ averaged over 24 hours; this is not to be exceeded more than once a year.

Samples were not collected during this quarter for trace metal analysis. The impactor for collecting samples during the early months of the project was on loan from the California Air Resources Board and was returned after May 1975. The impactor ordered for this project was delivered in late November. Sample collection will resume in December 1975.

c. Visibility

The clarity of the atmosphere on the tracts is monitored by three methods: (1) continuous recording of light-scattering coefficient with an integrating nephelometer at Station A-2, (2) photographic recording of visibility on color and monochromatic film from an observation point above Station A-9, and (3) visual observations at the same time as the photographic records are made.

The integrating nephelometer recorded an average scattering coefficient of $0.04 \times 10^{-3}\ m^{-1}$ during this quarter, which corresponds to a local visual range (assuming a 2 percent contrast threshold for the eye) of 118 km (73 mi). The highest scattering (lowest visual range) recorded was $b_s = 0.07 \times 10^{-3}\ m^{-1}$, which corresponds to 67 km (42 mi). This was observed several times during the quarter. The most clear hours had $b_s = 0.02 \times 10^{-3}\ m^{-1}$ (visual range 235 km, or 146 mi), which was last observed in the winter with snow cover on the ground. This latter value is of clarity comparable to that of particle-free air. All observed values have corresponded to extremely clear background-quality air.

TABLE III-9. Ambient air quality standards for particulate matter ($\mu g/m^3$).

Pollutant	Averaging Time	Utah Standards	National Standard	
			Primary	Secondary
Suspended Particulate Matter	Annual Geometric Mean	90	75	60
	24 hour	200	260	150

A diurnal variation in scattering coefficient was observed, with the night and early morning hours showing about 15 percent more scattering (lower visibility) than the afternoon and evening hours. This diurnal effect indicated that fine-scale particulates (of natural, or anthropogenic, origin) collect near the ground during the stable, calm night hours and are mixed into the atmosphere during the better ventilated hours and that the increased human activity and winds on the tracts during the day do not stir up enough dust to counteract this stability. This variation was not present in the summer but was observed last winter and spring.

Photographic visibility measurements were made September 1, October 2, and November 3. No obstructions to visibility occurred on any of these days.

The photographically-derived visibilities and those computed from the intergrating nephelometer measurements correlated well, indicating that the Uintah Basin air mass is relatively homogeneous and that the localized nephelometer measurements are representative of a large area.

4. RADIATION

Ambient radiation was continuously monitored throughout the tracts by a pressurized ion chamber, a portable ionization chamber survey meter, a NaI crystal scintillation counter, and thermo-luminescent dosimeters at all 12 stations. All showed radiation throughout the study area to be in the normal ambient range.

The pressurized ionization chamber, which is set up at each site in turn for six consecutive days, showed hourly exposure rates varying from 10 to 30 μR/hr, with most data around 15 μR/hr. Localized sources in the vicinity of the monitoring sites have indicated values up to about 60 μR/hr, still well within the background range. The late-summer values have tended to be slightly greater than those observed earlier.

The 30-day average radioactivity levels measured by thermo-luminescent dosimetry at all 12 stations from September 26 through October 25 are tabulated in Table III-10. These values are consistent with the ionization chamber data and also show a slight increase since summer.

Particulate matter collected on the high-volume sampler filters at Stations A-2 and A-6 has been analyzed for

TABLE III-10. Average radiation levels at all stations during 26 September - 26 October, as measured by three thermo-luminescent dosimeters at each station.

A1	-	9mR	A7	-	13mR
A2	-	10mR	A8	-	10mR
A3	-	10mR	A9	-	10mR
A4	-	14mR	A10	-	13mR
A5	-	10mR	A11	-	17mR
A6	-	13mR	A12	-	14mR

radiation by a gross alpha and beta measurement and a qualitative gamma radiation scan. The radioactivity of particulate samples collected during this quarter was relatively constant throughout the quarter. The gross alpha activity level was about 0.005 pCi/m^3 and the gross beta activity level was 0.03 pCi/m^3. Both the alpha and beta levels have decreased significantly since the beginning of the monitoring program and do not appear to be correlated either with the particulate mass concentrations or with the ambient radiation levels.

5. SOUND LEVELS

No sound-level measurements were made during the September-November period. A report on the previous survey in August appeared in the last quarterly report; the next survey will be in December.

C. WORK SCHEDULED

Routine continuous monitoring of air resources parameters will continue throughout the next quarter and will be supplemented by a scheduled sound-level survey in December and by regular monthly visibility measurements. Additional samples of water, shale, and air will be collected and analyzed for radioactivity to verify the results of previous measurements.

The scope of the monitoring program for the second baseline year will be defined, with emphasis on insuring that all necessary measurements are made in the most technically sound and cost-effective manner.

IV. BIOLOGICAL RESOURCES

A. WORK COMPLETED

1. VEGETATION

The third field inventory of the tracts was performed during the first week of September 1975. Previous inventories were made in the fall of 1974 and early June 1975. Four vegetation types--sagebrush/greasewood (Type 1), juniper (Type 2), shadscale (Type 3), and riparian (Type 4)--were studied as in previous inventories. Plant height in centimeters, plant cover in square centimeters, plant density in number of plants per plot, and productivity of perennial species per plot were calculated using a computer program adapted from the IBP Desert Biome.

2. TERRESTRIAL VERTEBRATES

During the quarter of September-November 1975, the large mammal telemetry program continued with a sequence of radio and ocular sightings of deer collared in May. A predator trapline was set during the quarter in an attempt to collar coyotes and bobcats. No predators have been trapped to date, but efforts are continuing.

Other ancillary observations were made during the quarter. A survey of raptors, game birds, and waterfowl identified more species and their estimated density.

The wildlife sampling program completed the first year collection during the October sampling period. Cold weather in the middle and latter parts of October interrupted the sampling of rodents and amphibians and reptiles. These taxa will not be sampled again until spring.

3. TERRESTRIAL INVERTEBRATES

During the September-November period, one visit was made (in September) to collect additional species, to take a series of sweep samples for quantitative counts, and to take photographs of sampling techniques and of prominent invertebrates. During October, the validation collection, now consisting of over 7,000 specimens, was organized,

and determinations of the order Diptera (flies) were begun. During November, the Diptera studies were carried on and several groups of arthropods were sent out to specialists for determination (spiders, springtails, long-legged flies, spider wasps). A list of the Diptera identified is included in the Field Data portion of Quarterly Report No. 5.

4. AQUATIC BIOLOGY

On-site aquatic biology studies were conducted from September 22 through October 2, 1975. Plankton, periphyton, macroinvertebrates, and fish were sampled and studied at the Bonanza, Utah laboratory. Off-site sample analysis continued through October.

Spring runoff in the White River abated in early August 1975. By the time sampling began in late September, conditions in the river had been stable for approximately two months. The protracted period of low discharge and increased transparency were probably responsible for the greater concentrations of phytoplankton and other signs of increased productivity. During the on-site work, discharge averaged about 420 cfs. The weather was fair, and conditions were ideal for field work.

The periphyton samplers designed after U.S.G.S. models proved unsatisfactory and were removed from service in September. The samplers became waterlogged, causing the downstream ends to sag below the water surface. The attached mylar collecting strips were submerged as much as 10 cm (4 in.). Solar exposure was reduced by turbidity or completely eliminated when the strips became buried in silt. The floats were thoroughly dried during October and covered with a waterproof epoxy finish. The metal bars that hold the collecting strips were straightened to display the strips horizontally rather than vertically. The modified floats, placed back in service November 3, were tethered from crossing cables in midstream to prevent their being buried in silt or stranded on the bank as discharge recedes.

The sampler at Station F-1 was carried away by floating ice on November 26, so the rest were removed to prevent further loss. The samples collected were sent to a U.S.G.S. laboratory according to U.S.G.S. instructions. Data will be reported upon receipt.

5. MICROBIOLOGY

The soil microbiology program continued with the addition of the results of nitrification and ATP concentration parameters from samples collected previously.

B. DATA SUMMARY

1. VEGETATION

Two-person inventory teams (Figure IV-1) made estimates of plant characteristics and obtained production samples on $4m^2$ plots. A $0.25m^2$ wire grid was used to estimate cover in $100cm^2$ units. Production estimates of shrubs and trees were made by clipping the current year's growth from a $100cm^2$ area of canopy and multiplying the air dry weight of the sample by the estimated total cover of that species in the same $4m^2$ plot. Height was directly measured with a meter stick. Numbers of plants, by species, were counted in each $4m^2$ plot and are reported only for plots in which plants were encountered.

As a result of botanical collections and inventories in the area, a species list has been compiled (Table IV-1). Many of the species thus listed have been identified by botanists at the Intermountain Herbarium from voucher specimens deposited there. The other species were identified in the field.

The productivity of each vegetation type on the tracts differs. (See Tables IV-2, 3, 4, and 5.) The data are compiled on the basis of 100 plots, even though various plant species do not occur in all of the plots. The reason for computing the data in this manner is to provide an estimate of the general productivity of the entire area, bare ground excluded. In order of productivity, the sagebrush/greasewood type produced 428.9 $g/4m^2$; the juniper type, 559.8 $g/4m^2$; the shadscale type, 608.3 $g/4m^2$; and the riparian, 2908.8 $g/4m^2$. Converted to kg/ha (lb/acre) these figures become:

Sagebrush/greasewood	1,072.2 kg/ha	(956.7 lb/acre)
Juniper	1,399.5 kg/ha	(1248.7 lb/acre)
Shadscale	1,520.8 kg/ha	(1356.8 lb/acre)
Riparian	7,272.0 kg/ha	(6488.2 lb/acre)

FIGURE IV-1

INVENTORY TEAM MAKING AN ESTIMATE OF PLANT COVER, HEIGHT, DENSITY AND PRODUCTIVITY

TABLE IV-1

SIX-LETTER COMPUTER CODES FOR SCIENTIFIC PLANT NAMES

Six Letter Plant Code	Scientific Name
ABRELL	*Abronia elliptica*
ABRFRA	*Abronia fragrans*
ACHMIL	*Achillea millefolium*
AGRINE	*Agropyron inerme*
AGRREP	*Agropyron repens*
AGRSMI	*Agropyron smithii*
ALLIUM	*Allium* spp.
ALYOES	*Allyssum dessrtorum*
AMBPSI	*Ambrosia psilostachya*
AMEUTA	*Amelanchier utahensis*
AREKIN	*Arenaria kingii*
ARTEMI	*Artemisia* spp.
ARTFRI	*Artemisia frigida*
ARTLUD	*Artemisia ludoviciana*
ARTNOV	*Artemisia nova*
ARTSPI	*Artemisia spinescens*
ARTTRI	*Artemisia tridentata*
ASCCRY	*Asclepias cryptoceras*
ASTCAN	*Astragalus canadensis*
ASTCON	*Astragalus convallarius*
ASTRAG	*Astragalus* spp.
ASTCYM	*Astragalus cymboides*
ASTMOLL	*Astragalus mollissimus*
ASTSIM	*Astragalus simplifolcius*
ATRCAN	*Atriplex canescens*
ATRCON	*Atriplex confertifolia*
ATRCUN	*Atriplex cuneata*
ATRIPL	*Atriplex*
ATRPAT	*Atriplex patula*
ATRPOW	*Atriplex powellii*
BAIMUL	*Baileya multiradiata*
BARGRO	BARE GROUND
BASHYS	*Bassia hyssopifolia*
BORAGI (BORAGE)	Boraginaceae
BROTEC	*Bromus tectorum*
CARYOP	Caryophyllaceae
CASCHR	*Castillija chromosa*
CERLAN	*Ceratoides lanata*
CIRSIU	*Cirsium* spp.
CHEALB	*Chenopodium album*
CHOTEN	*Chorispora tenella*
CHRVIL	*Chrysopsis villosa*
CHRGRE	*Chrysothamnus greeni*
CHRNAU	*Chrysothamnus nauseosus*
CHRVIS	*Chrysothamnus viscidiflorus*
CLELUT	*Cleome lutea*
CLESER	*Cleome serrulata*
COMPAL	*Comandra pallida*
CRUCIF	Cruciferae
CRYAFF	*Cryptantha affinis*
CRYFLA	*Cryptantha flavoculata*
CRYGRA	*Cryptantha gracilis*
CRYLON	*Cryptantha longiflora*
CRYSER	*Cryptantha sericea*
CYMOPT	*Cymopteris* spp.
CYMACA	*Cymopterus acaulis*
CYMFEN	*Cymopterus fendleri*
DELBAR	*Delphinium barbeyi*
DELPHI	*Delphinium* spp.
DESPIN	*Descurainia pinnata*
DESSOP	*Descurania sophia*
DISSPI	*Distichlis spicata*
DISSTR	*Distiahlis stricta*
EPHVIR	*Ephedra virdis*
EQUARV	*Equisetum arvense*
ERIGER	*Erigsron* spp.
ERIENG	*Erigeron eugelmannii*
ERIURS	*Erigeron ursinus*
ERIOGO	*Eriogonum* spp.
ERIBAT	*Eriogonum batemanii*
ERIEFF	*Eriogonum effusum*
ERIMIC	*Eriogonum microthecum*
ERIOVA	*Eriogonum ovalifolium*
EUPHOR	*Euphorbia* spp.
EUPFEN	*Euphorbia fendelri*
EUPROB	*Euphorbia robusta*
EURLAN	*Eurotia lanata*
FESCUE (FESTUC)	*Festuca* spp.
FESOCT	*Festuca octoflora*
FORMEI	*Forsellesia meionandra*
GALCOL	*Galium coloradense*
GILCON	*Gilia congesta*
GILLEP	*Gilia leptomeria*
GILSIN	*Gilia sinuata*
GILSTE	*Gilia stenothyrsa*
GILPOL	*Gilia polycladon*
GRASPI	*Grayia spinosa*
GRISQU	*Grindelia squarosa*
GUTSAR	*Gutierrezia sarothrae*
HALGLO	*Halogoton glomeratus*
HEDBOR	*Hedysarum boreale*
HILJAM	*Hilaria jamesii*
HOLMIC	*Holodiscus microphyllus*
HORJUB	*Hordeum jubatum*

TABLE IV-1 (CON'T)

Six Letter Plant Codes	Scientific Name
HYMACA	*Hymenoxys ocoulis*
HYMENO	*Hymenoxys* spp.
HYMSCA	*Hymenoxys scaposo*
IVAAXI	*Iva axilloris*
JUNBAL	*Juncus bolticus*
JUNOST	*Juniperus osteospermo*
KOCAME	*Kochio Americana*
KOCHIA	*Kochia* spp.
KOCSCO	*Kochia scopario*
KOCVES	*Kochia vestito*
LAPRED	*Lappula redowskii*
LEPIDI	*Lepidium* spp.
LEPMON	*Lepidium montanum*
LEPPER	*Lepidium perfoliotum*
LEPPUN	*Leptodoctylon pungens*
LEPRED (LAPRED)	*Lappula redowskii*
LEPWAT	*Leptodactylon watsonii*
LITRUD	*Lithospermum ruderole*
LITTER	Litter
LOLPER	*Lolium perenne*
MALAFR	*Malcomia ofricana*
MALSON	*Malcothrix sanchoides*
MELOFF	*Melilotis officinolis*
MENALB (MENALS)	*Mentzelia olbicoulis*
MENHUM	*Mentzelia humilis*
MULASP	*Muhlenbergia asperifolia*
OENCAE	*Oenothera caespitosa*
OENDEN	*Oenothera deltoides*
OENMIN	*Oenothera minor*
OGNSCA	*Oenothero scopoidea*
OPUNTI	*Opuntio* spp.
OPUPOL	*Opuntia polycantho*
OROGAS	*Orobanche fasciculota*
OROLUD	*Orobanche ludoviciano*
ORYHYM	*Oryzopsio hymenoides*
OXYLIN	*Oxybaphus linearis*
PENFRE	*Penstemon fremontii*
PETPUM	*Petradoria pumila*
PHACEL	*Phacelia* spp.
PHACOR	*Phacelio corrugata*
PHLHOO	*Phlox hoodii*
PHLLON	*Phlox longifolia*
PHRCOM	*Phragmites communis*
PHYALT	*Physocarpus alternans*
PHYMON	*Physocarpus monogynom*
PINEDU	*Pinus edulis*
PLAPAT	*Plantago patagonica*
POAPRA (POAPRE)	*Poa pratensis*

Six Letter Plant Code	Scientific Name
POASAN	*Poa sandbergii*
POLTRA	*Polanisio trachysperma*
POPANG	*Populus angustifolio*
POPFRE	*Populus fremontii*
RANTES	*Ranunculus testiculotus*
RHUTRI	*Rhus trilobota*
ROSWOO	*Roso woodsii*
SALEXI	*Salix exigua*
SALKAL	*Salsolo kali*
SARVER	*Sarcobatus vermiculatus*
SCIAME	*Scirpus americanus*
SCIPAL	*Scirpus paludosus*
SENECI	*Senecio* spp.
SISALT	*Sisymbrium altissimum*
SISLIN	*Sisymbrium linifolium*
SITHYS	*Sitanion hystrix*
SPAGRA	*Spartina gracilis*
SPHAER (SPIRAL)	*Sphaeralcio* spp.
SPHCOC	*Sphaeralcea coccinea*
SPHMUN	*Sphoerolcea munroana*
SPHPAR	*Sphaeralcea parvifolio*
SPOAIR	*Sporobolus airoides*
SPOCRY	*Sporobolus cryptandrus*
STALIT (SSTALI)	Standing dead annuals
STICOM (STYCOM)	*Stipa comata*
STRCOR	*Streptanthus cordatus*
SUADIA (SUAEDA)	*Suaeda*
SUAFRU	*Suaeda fruticoso*
SUANIG	*Suaeda nigra*
SUASUF	*Suaeda suffrutescens*
SUATOR	*Suaeda torreyana*
TAMPEN	*Tamarix pentandro*
TAROFF	*Taraxacum officinale*
TETNUT	*Tetradymia nuttallii*
TETSPI	*Tetradymia spinosa*
TOWINC	*Townsendio incana*
TRADUB	*Tragopogon dubius*
UMBELL	*Umbelliferae*
VULOCT	*Vulpia octoflora*

TABLE IV-2

PRODUCTION BY SPECIES
SAGEBRUSH/GREASEWOOD, VEGETATION TYPE I

Species[1)]	Yield, g/plot	No. Obs.	No. Samples Required[2)]
ARTSPI	6.49	7	42.3
ARTTRI	66.25	64	37.8
ASTRAG	.63	1	-
ATRARG	1.88	1	-
ATRCON	56.04	94	24.0
ATRPOW	.75	1	-
BARGRO[3]	845.10	100	1.0
CHRGRE	21.73	13	73.8
ERIEFF	10.00	15	81.5
ERIENG	.75	24	36.0
ERIOGO	.38	3	4.8
EURLAN	1.96	5	36.4
GRASPI	21.67	3	17.3
GUTSAR	5.96	37	505.5
HALGLO	10.00	5	216.4
HILJAM	16.68	9	41.6
OPUNTI	7.06	14	52.6
ORYHYM	6.99	28	823.1
SARVER	23.23	18	71.1
SITHYS	1.75	2	15.9
SPHCOC	1.19	14	36.9
SPHPAR	.50	2	21.6
SPOAIR	20.63	2	35.1
SPOCRY	6.17	8	13.5
STALIT	32.83	98	95.3
STICOM	3.49	10	104.8
SUASUF	4.50	5	74.9
TETNUT	74.69	2	1.7
TETSPI	24.77	15	73.6

Average Yield/100 plots all species = 1273.99 g - BARGRO = 428.9 g

1) Refer to Table IV-1 for computer code's scientific names.

2) No. samples required to estimate within 25% the true mean with a 90% level of statistical confidence.

3) Decomposing litter, shrub stems and other organic debris.

TABLE IV-3

PRODUCTION BY SPECIES
JUNIPER, VEGETATION TYPE 2

Species	Yield, g/plot	No. Obs.	No. Samples Required 2/
ARTNOV	21.64	24	61.5
ARTTRI	2.50	1	-
ASTRAG	2.50	1	-
ATRCON	6.44	12	58.8
BARGRO 3	774.15	40	6.7
CHRVIS	21.25	4	59.8
CRYPTA	1.75	10	19.4
ORYHYM	.63	1	-
ORICIR	1.48	5	19.8
ERIMIC	.77	7	8.6
ERIOGO	.38	2	-
ERIVIS	.13	1	-
EUPFEN	1.76	11	28.8
GUTSAR	1.13	19	32.3
HILJAM	.88	2	15.9
JUNOST	315.80	21	46.3
OPUPUL	5.00	1	-
ORYHYM	2.72	8	29.6
PETPUM	4.01	11	53.7
PHLHOO	6.56	2	70.9
PINEDU	125.00	2	-
RANTES	.44	2	15.9
STALIT	36.05	36	149.0
STICOM	1.00	6	32.7

Average Yield/100 plots all species = 1333.97 g - BARGRO = 774.2 g

1) Refer to Table IV-1 for computer code's scientific names.

2) No. samples required to estimate within 25% the true mean with a 90% level of statistical confidence.

3) Decomposing litter, shrub stems and other organic debris.

TABLE IV-4

PRODUCTION BY SPECIES
SHADSCALE, VEGETATION TYPE 3

Species	Yield, g/plot	No. Obs.	No. Samples Required[2]
AMBSPI	2.50	1	-
ARTNOV	42.44	22	69.6
ARTSPI	34.63	5	71.7
ARTTRI	69.35	47	29.6
ASTRAG	.76	5	73.6
ATRCON	12.74	38	25.7
BARGRO[3]	685.96	100	5.1
CHRGRE	34.16	38	57.5
CHRNAU	66.10	2	-
EPHUIR	3.75	2	86.6
ERIENG	1.08	6	40.3
ERIOGO	2.34	13	28.5
EURLAN	6.91	8	34.1
GRASPI	58.20	29	33.6
GUTSAR	7.35	14	55.2
HILJAM	11.60	10	27.5
HYMENO	1.88	2	9.6
LEPMON	12.50	3	-
OPUNTI	2.75	2	-
ORYHYM	16.71	49	36.5
SARVER	61.89	40	69.0
SITHYS	3.88	6	30.6
SPHCOC	4.63	4	94.3
SPOCRY	3.96	3	26.0
STALIT	104.54	99	45.0
STICOM	24.42	39	47.0
SUAEDA	8.54	3	1.5
TETSPI	17.71	6	27.2

Average Yield/100 plots all species = 1294.28 g - BARGRO = 608.3 g

1) Refer to Table IV-1 for computer code's scientific names.

2) No. samples required to estimate within 25% the true mean with a 90% level of statistical confidence.

3) Decomposing litter, shrub stems and other organic debris.

TABLE IV-5

PRODUCTION BY SPECIES
RIPARIAN, VEGETATION TYPE 4

Species	Yield, g/plot	No. Obs.	No. Samples Required[2]
AGRSMI	25.84	24	278.0
AMBPSI	4.76	5	120.0
ARTLUD	.75	1	-
ARTTRI	22.25	6	30.2
ATRCAN	33.79	3	73.8
ATRCON	3.00	1	-
ATRPAT	4.26	21	27.6
ATRPOW	2.50	1	-
BARGRO[3]	163.44	100	125.3
CHRNAU	57.23	27	175.7
CHRVIS	56.95	46	76.8
CIRSIU	10.63	2	-
CLELIG	7.75	2	-
CLESER	5.00	2	-
COMPAL	18.19	11	67.3
DESSOP	-	1	-
DIFFDI	25.00	1	-
DISSPI	35.14	48	74.6
EMLORF	.50	1	-
EQUARV	73.23	6	107.0
ERIENG	.88	3	22.1
GRISQU	.75	1	-
GUTSAR	.50	1	-
JUNBAL	4.40	5	32.7
MELOFF	15.75	25	53.3
MUHASP	262.50	2	-
OPUNTI	.75	1	-
PHRCON	24.00	3	31.0
POAPRA	73.10	5	34.0
POPFRE	522.47	31	27.7
RHUTRI	.38	1	-
ROSWOO	8.75	1	-
SALEXI	118.13	13	89.1
SALKAL	23.00	16	78.2
SARVER	175.19	12	93.2
SENELI	23.70	1	-
SPOAIR	33.75	3	61.7
SSTALI	400.00	1	-
STALIT	691.53	99	8.3
TAMPEN	110.00	13	29.4
TAROFF	32.50	1	-

Average Yield/100 plots all species = 3072.24 g - BARGRO = 2908.8 g

1) Refer to Table IV-1 for computer code's scientific names.
2) No. samples required to estimate within 25% the true mean with a 90% level of statistical confidence.
3) Decomposing litter, shrub stems and other organic debris.

This productivity represents the current year's growth of the perennial forbs, grasses, trees, and shrubs on an area-wide basis, assuming that the five sampling sites for each vegetation type and the 20 randomly-chosen $4m^2$ plots within each site are representative of the vegetation type.

The 1975 growing season was extremely favorable for vegetative productivity. Many of the shrub species sampled had stem growth of almost double the length observed in the late September sampling period of 1974. Contrasted with extremely dry years, perennial plant productivity of both 1974 and 1975 must be considered high for any long-term average.

The data in Tables IV-2 through IV-5 cannot be compared directly with the production data reported for the fall 1974 because a different basis of calculation was used to arrive at a better level of statistical confidence. For the 1974 data only the actual number of plots in which a species occurred was used as a basis. Although either method is correct, using the actual plot basis production is estimated as it occurs within a clumped or aggregated plant grouping, while estimates made using the total plot basis (100 plots) indicate productivity for the entire surface, including bare areas.

Vegetation attributes sampled in the September field inventory were similar to those obtained in earlier inventories except for seasonal differences. Plant heights were not generally different from those recorded in the spring except for a few species that produced elongated stems in response to the favorable growing conditions (Tables IV-6, 7, 8, and 9). For example, the average height of *Artemisia tridentata* in June 1975 was 20 cm and in September it was 29 cm in the shadscale vegetation type. Other examples are: *Atriplex confertifolia*, 15 cm in the spring and 19 cm in the fall; *Gutierrezia sarothrae*, 11 cm in the spring and 20 cm in the fall; and *Tetrademia spinescens*, 32 cm in the spring compared with 33 cm in the fall. Many of the shrubs produce new twig length within the canopy and this growth either dies back or is consumed by animals. The net result is that plants generally maintain a characteristic height in relation to a given site after maturity is reached. Thus, on the west-facing slopes of the shadscale type the typical shrub vegetation is about 20 cm high while in the sagebrush/greasewood type the dominant plants are 30 to 33 cm high. In the juniper type the average height of juniper is 172 cm but the understory shrubs and grasses are about 15 cm in height.

TABLE IV-6
SAGEBRUSH/GREASEWOOD VEGETATION CHARACTERISTICS

VEGETATION TYPE 1

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	Sample Size	NUM OBS	MEAN	90% C.I.	Sample Size	NUM OBS	MEAN	90% C.I.	Sample Size
ARTFRI	1	43.0	- -	-	1	600.0	- -	-	1	1.0	- -	-
ARTSPI	13	9.8	11.9 7.7	11.7	7	249.3	352.8 145.8	20.6	7	2.4	4.5 0.3	89.8
ARTTRI	136	29.2	31.1 27.3	12.9	64	2395.9	2850.8 1941.1	52.4	64	5.1	6.5 3.8	99.0
ASTRAG	1	4.0	- -	-	1	25.0	- -	-	1	1.0	- -	-
ATRARG	-	-	- -	-	1	75.0	- -	-	1	14.0	- -	-
ATRCON	399	24.6	32.8 16.4	1008.0	94	2241.7	2524.7 1958.7	34.0	94	8.8	10.3 7.3	63.1
ATRPOW	-	-	- -	-	1	30.0	- -	-	1	1.0	- -	-
BARGRO	20	1.0	- -	-	100	33803.9	34489.0 33118.7	0.9	100	1.0	1.0 1.0	-
CHRGRE	21	26.5	28.7 24.3	3.0	13	869.2	1426.7 311.6	104.8	13	2.2	3.2 1.2	54.9
ERIEFF	38	23.1	25.6 20.6	15.9	15	400.0	648.4 151.6	115.7	15	6.9	9.1 4.8	28.4
ERIENG	22	16.1	19.2 3.3	16.3	24	330.1	39.7 20.5	51.1	24	4.9	6.5 3.2	57.6
ERIOGO	3	16.3	29.4 3.3	21.3	3	15.0	21.8 8.2	6.8	3	11.7	30.9 -7.6	90.5
EURLAN	8	11.5	14.4 8.6	9.0	6	78.3	126.9 39.8	37.5	6	1.8	2.8 0.9	25.0
GRASPI	2	43.5	- -	-	3	866.7	- -	-	3	1.0	- -	-
GUTSAR	36	19.7	21.4 18.0	6.1	37	238.4	458.6 18.1	717.8	37	7.5	10.3 4.6	123.2
HALGLO	0	-	- -	-	5	400.0	1206.0 -406.0	308.3	5	42.4	82.1 2.7	66.3
HILJAM	9	23.7	33.7 13.6	29.5	9	675.0	1079.3 270.7	59.1	9	10.9	16.0 5.8	36.1
OPUNTI	20	7.6	8.6 6.6	7.2	13	282.3	435.2 129.4	74.7	13	1.6	2.2 1.1	29.6
OPUSPP	3	5.7	9.8 1.5	17.9	1	525.0	- -	-	1	3.0	- -	-
ORYHYM	28	20.8	23.4 18.2	9.2	28	279.8	671.9 -112.4	1168.8	28	5.9	11.3 0.6	458.4
SALKAL	-	-	- -	-	5	-	- -	-	5	15.8	24.0 7.6	20.4
SARVER	22	33.1	40.6 25.6	23.5	13	1286.4	1890.1 682.7	56.1	13	1.9	2.4 1.4	17.9
SITHYS	2	21.0	- -	-	2	70.0	- -	-	2	3.0	- -	-
SPHCOC	14	18.1	21.9 14.4	12.0	14	47.7	68.4 27.0	52.4	14	2.8	3.9 1.7	46.5
SPHPAR	2	21.5	- -	-	2	20.0	- -	-	2	1.5	- -	-
SPOAIR	2	7.0	- -	-	2	825.0	- -	-	2	7.5	- -	-
STICOM	10	46.9	55.0 38.8	5.6	10	139.5	263.9 15.1	148.8	10	2.2	3.0 1.5	22.0
SUASUE	5	31.6	43.0 20.3	9.7	5	180.0	393.4 -33.4	106.4	5	1.6	2.4 0.8	19.2
TETNUT	6	35.0	45.8 24.3	9.2	2	2987.5	- -	-	2	4.0	- -	-
TETSPI	20	33.3	38.4 28.3	9.5	15	990.7	1575.2 406.1	104.5	15	2.0	2.7 1.3	32.9

DATA ARE FOR THE NUMBER OF OBSERVATIONS, MEAN, 90% CONFIDENCE INTERVAL ABOUT THE MEAN AND SAMPLE SIZE REQUIRED TO ESTIMATE WITHIN 25% OF THE MEAN WITH A 90% STATISTICAL CONFIDENCE.

TABLE IV-7
JUNIPER VEGETATION CHARACTERISTICS
VEGETATION TYPE 2

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	Sample Size	NUM OBS	MEAN	90% C.I.	Sample Size	NUM OBS	MEAN	90% C.I.	Sample Size
ARTNOV	85	18.5	20.6 16.5	16.6	24	865.5	1225.7 505.2	61.5	24	3.9	5.2 2.7	34.9
ARTTRI	0	-	- -	-	1	-	- -	-	1	-	- -	-
ASTRAG	1	30.0	- -	-	1	-	- -	-	1	-	- -	-
ATRCON	18	16.4	22.1 10.7	31.2	12	257.6	34134.6 27797.7	6.7	12	1.5	1.0 1.0	-
CHRVIS	4	28.5	35.8 21.2	2.5	4	850.0	1914.9 -214.9	59.8	4	1.3	1.8 .7	6.9
CRYPTA	10	6.3	7.7 4.9	6.3	10	70.0	96.9 43.1	19.4	10	2.3	3.4 1.2	27.4
ERICIR	5	25.8	37.7 13.9	11.4	5	59.0	95.1 23.1	19.8	5	1.6	2.4 .8	13.5
ERIMIC	6	13.5	16.5 10.5	3.3	7	30.7	40.5 20.9	8.6	7	2.1	3.1 1.2	17.1
ERIOGO	2	17.5	- -	-	2	15.0	- -	-	2	1.5	- -	-
EUPFEN	11	3.6	4.1 3.2	2.1	11	70.5	101.6 39.4	28.8	11	2.3	2.9 1.6	11.9
GUTSAR	19	16.9	19.8 14.1	7.7	19	45.1	60.4 29.6	32.3	19	1.7	2.2 1.3	17.3
HILJAM	2	15.0	- -	-	2	35.0	- -	-	2	4.0	- -	-
JUNOST	10	171.8	231.6 112.0	16.0	21	12632.1	17541.1 7723.2	46.3	21	1.1	1.3 .9	6.9
OPUPUL	1	8.0	- -	-	1	200.0	- -	-	1	2.0	- -	-
ORYHYM	8	25.3	33.0 17.5	9.4	9	108.9	168.1 49.7	29.6	9	3.9	5.6 2.1	20.1
PETPUM	12	16.4	19.9 12.9	7.5	11	160.6	257.4 63.7	53.7	11	3.1	4.5 1.7	32.1
PHLHOO	2	6.0	- -	-	2	262.5	- -	-	2	2.5	- -	-
PINEDU	1	40.0	- -	-	2	100.0	- -	-	2	1.0	- -	-
RANTES	2	8.5	- -	-	2	17.5	- -	-	2	1.0	- -	-
STALIT	0	-	- -	-	36	1441.9	2177.4 706.2	149.9	36	1.0	1.0 1.0	-
STICOM	6	32.0	40.9 23.1	5.3	6	40.0	67.6 12.4	32.7	6	1.8	3.1 .6	33.1

DATA ARE FOR THE NUMBER OF OBSERVATIONS, MEAN, 90% CONFIDENCE INTERVAL ABOUT THE MEAN AND SAMPLE SIZE REQUIRED TO ESTIMATE WITHIN 25% OF THE MEAN WITH A 90% STATISTICAL CONFIDENCE.

TABLE IV-6
SHADSCALE VEGETATION CHARACTERISTICS

VEGETATION TYPE 3

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	Sample Size	NUM OBS	MEAN	90% C.I.	Sample Size	NUM OBS	MEAN	90% C.I.	Sample Size
AMBPSI	1	47.0	- -	-	1	100.0	- -	-	1	1.0	- -	-
ARTNOV	81	16.5	18.1 14.9	17.9	22	1697.7	2485.7 909.7	69.6	22	4.6	5.6 3.7	13.0
ARTSPI	22	8.5	9.7 7.2	6.8	5	985.0	2127.6 -157.6	71.7	5	6.6	15.0 -1.8	86.3
ATRTRI	160	29.2	31.1 27.3	10.0	47	2773.9	3324.6 2223.4	29.6	47	4.9	5.8 4.1	23.2
ASTRAG	4	5.5	9.1 1.9	15.7	5	30.4	66.1 -5.3	73.6	5	4.2	7.4 .9	31.2
ATRCON	46	18.9	20.9 16.9	8.4	26	509.0	640.7 378.8	25.7	26	2.2	2.7 1.7	21.8
BARGRO	-	-	- -	-	99	22715.5	29046.9 26384.1	3.7	99	1.0	1.0 1.0	-
CHRGRE	56	32.3	34.8 29.7	5.5	28	1366.4	1872.5 860.3	57.5	28	3.2	4.4 2.1	54.2
CHRNAU	2	56.0	- -	-	2	4000.0	- -	-	2	1.0	- -	-
EPHVIR	1	25.0	- -	-	2	150.0	- -	-	2	1.0	- -	-
ERIENG	6	20.0	24.2 15.8	4.1	6	43.3	76.4 10.2	40.0	6	1.2	1.4 .8	5.0
ERIOGO	12	17.3	19.6 15.0	4.1	13	93.5	130.7 56.2	40.4	13	1.6	2.1 1.1	25.7
EURLAN	8	22.5	30.0 14.9	11.3	7	276.4	452.1 100.8	34.1	7	1.3	1.8 .7	15.0
GRASPI	60	35.0	37.4 32.5	4.7	29	2360.7	3029.4 1692.0	33.6	29	2.3	2.7 1.7	26.3
GUTSAR	14	19.9	22.8 17.0	4.2	14	293.9	450.1	55.2	14	4.9	7.8 2.0	68.1
HILJAM	10	22.4	27.3 17.4	6.3	10	464.0	676.1 251.9	27.5	10	8.5	10.8 6.1	10.3
HYMENO	1	5.0	- -	-	2	75.0	- -	-	2	2.0	- -	-
LEPMON	3	43.3	53.7 32.9	1.3	3	500.0	500.0 500.0	-	3	3.6	4.4 2.9	1.1
OPUNTI	2	6.5	16.7 -3.7	25.1	2	110.0	- -	-	2	1.0	- -	-
ORYHYM	50	45.4	48.3 42.6	3.1	49	668.6	812.7 524.3	36.5	49	105.8	373.1 -61.8	1968.1
SARVER	60	49.1	55.2 42.7	15.1	40	2475.6	3288.8 1662.5	69.1	40	2.1	2.6 1.5	44.1
SITHYS	6	23.2	29.2 17.1	4.7	5	155.0	272.3 37.5	30.6	5	1.2	1.6 .8	6.0
SPHCOC	4	20.0	31.7 8.2	8.1	4	185.0	555.9 -185.1	34.3	4	2.0	4.3 -.3	32.5
SPOCRY	3	28.3	36.2 20.5	1.8	3	158.3	325.8 -9.2	26.3	3	1.7	3.2 .1	20.8
STALIT	-	-	- -	-	99	7381.6	8636.1 5885.1	65.1	99	1.0	- -	-
STICOM	39	60.5	64.5 56.7	2.6	39	976.9	1249.4 304.7	47.2	39	13.6	16.9 10.3	35.9
SUAEOA	6	45.1	57.3 32.7	5.1	3	341.7	427.1 256.2	1.5	3	2.0	3.4 .6	10.8
TETSPI	6	34.6	42.6 26.7	3.6	6	708.3	1153.8 262.8	27.2	6	1.0	1.0 1.0	-

DATA ARE FOR THE NUMBER OF OBSERVATIONS, MEAN, 90% CONFIDENCE INTERVAL ABOUT THE MEAN AND SAMPLE SIZE REQUIRED TO ESTIMATE WITHIN 25% OF THE MEAN WITH A 90% STATISTICAL CONFIDENCE.

TABLE IV-8

RIPARIAN VEGETATION CHARACTERISTICS

VEGETATION TYPE 4

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	Sample Size	NUM OBS	MEAN	90% C.I.	Sample Size	NUM OBS	MEAN	90% C.I.	Sample Size
AGRSMI	24	76.4	86.4 66.4	6.1	24	1033.7	1948.7 118.8	278.0	24	13.8	23.5 4.2	172.0
AMBPSI	5	36.4	78.1 -6.1	72.1	5	190.1	477.1 -96.3	120.0	5	9.2	20.9 -2.5	85.1
ARTLUD	1	47.1	- -	-	1	350.0	- -	-	1	1.0	- -	-
ARTTRI	6	54.3	88.1 20.5	26.6	6	890.0	1479.9 300.1	30.2	6	3.5	6.5 .4	53.4
ATRCAN	2	37.1	121.6 -47.7	53.1	3	1351.7	3749.1 1046.0	73.1	3	1.0	1.0 1.0	-
ATRCON	1	85.1	- -	-	1	120.0	- -	-	1	-	- -	-
ATRPAT	21	39.7	50.5 28.9	22.1	21	170.5	221.1 119.1	27.1	21	9.5	14.7 4.3	90.0
ATRPOW	1	28.1	- -	-	1	100.1	- -	-	1	1.0	- -	-
BARGRO	-	-	- -	-	100	6537.5	8374.1 4700.0	-	100	1.0	- -	-
CHRNAU	24	84.4	94.8 74.1	5.3	27	2289.2	3800.7 777.8	175.7	27	1.6	2.1 1.3	16.8
CHRVIS	45	87.2	99.1 75.2	13.4	46	2277.8	3013.0 1541.0	76.8	46	5.9	7.4 4.5	42.3
CIRSIU	3	6.0	34.6 5.4	5.4	3	425.0	498.0 352.0	.3	3	6.5	7.9 5.0	.5
CLELIG	2	15.0	- -	-	2	310.0	- -	-	2	1.0	- -	-
CLESER	2	50.0	- -	-	2	200.0	- -	-	2	2.5	- -	-
COMPAL	11	25.2	30.4 19.9	6.4	11	727.7	1219.0 236.0	67.3	11	32.3	47.0 17.0	31.2
DESSUP	1	22.0	- -	-	1	5600.0	- -	-	1	1.0	- -	-
DIFFOI	1	27.0	- -	-	1	1000.0	- -	-	1	-	- -	-
DISSPI	48	23.4	25.4 21.5	5.5	48	1405.0	1843.0 967.0	74.6	48	53.4	68.1 38.6	58.4
EQUARV	6	48.8	70.8 26.8	13.9	6	2929.0	6590.0 -731.0	107.0	6	324.8	528.7 66.9	43.0
GRISQU	1	37.0	- -	-	3	35.0	68.9 1.0	49.0	3	3.0	7.7 -1.7	128.0
GUTSAR	1	37.0	- -	-	1	20.0	- -	-	1	1.0	- -	-
JUNBAL	5	52.6	81.7 23.4	16.4	5	176.0	313.8 38.2	32.7	5	74.4	137.3 11.5	38.1
MELOFF	25	17.5	21.4 13.7	25.6	25	629.9	858.8 391.0	75.7	25	56.6	85.5 27.8	136.0
MUHASP	2	54.0	- -	-	2	10500.0	- -	-	2	178.0	- -	-
OPUNTI	1	6.0	- -	-	1	30.0	- -	-	1	1.0	- -	-
PHRCOM	3	153.3	202.4 24.2	16.6	3	960.0	2072.0 -152.0	31.5	3	44.3	103.5 -14.8	41.0
POAPRA	5	45.25	83.4 7.1	27.1	5	2925.0	5698.4 151.5	34.2	5	94.0	159.6 38.4	18.0
POPFRE	14	1300.4	1825.7 775.1	31.9	31	20898.0	35836.0 15961.0	27.7	31	2.5	3.4 1.7	56.9
SHUTRI	1	13.0	- -	-	1	15.0	- -	-	1	2.0	- -	-
ROSWOO	1	32.0	- -	-	1	350.0	- -	-	1	2.0	- -	-
SALEXI	12	280.7	464.9 96.4	70.5	13	4725.4	8056.2 1394.5	89.1	13	2.5	3.2 1.7	16.2
SALKAL	16	32.3	38.8 25.8	9.2	16	920.2	1460.2 380.2	78.2	16	48.9	77.2 20.6	75.8
SARVER	9	103.4	143.3 63.6	38.0	12	7007.0	1229.5 1719.0	206.0	12	1.7	2.5 .7	109.0
SENECI	1	98.0	- -	-	1	950.0	- -	-	1	17.0	- -	-
SPOAIR	3	49.0	67.1 12.8	10.8	3	1350.0	3539.0 -839.0	61.7	3	1.7	3.2 .1	20.1
SSTALI	0	-	- -	-	1	16000.0	- -	-	1	1.0	- -	-
STALIT	0	-	- -	-	99	27661.0	29666.0 25656.0	8.3	99	1.0	- -	-
TAMPEN	10	306.7	464.8 148.6	77.8	13	4400.0	6181.0 2681.0	65.3	13	2.3	3.5 1.1	115.4
TAROFF	1	6.0	- -	-	1	1300.0	- -	-	1	-	- -	-

DATA ARE FOR THE NUMBER OF OBSERVATIONS, MEAN, 90% CONFIDENCE INTERVAL ROUND THE MEAN AND SAMPLE SIZE REQUIRED TO ESTIMATE WITHIN 25% OF THE MEAN WITH A 90% STATISTICAL CONFIDENCE.

Plant cover is a variable attribute of vegetation and is related to plant age and size and the natural aggregation of species into clumps. A large amount of open space exists which adds variability to data for plant cover and requires a large number of sampling plots. The mean cover value ($cm^2/4m^2$ plot) for each vegetation type is as follows: sagebrush/greasewood, 16,200 cm^2 per plot; juniper, 15,820 cm^2 per plot; shadscale, 21,590 cm^2 per plot; and riparian, 78,480 cm^2 per plot. These are rounded values and do not include the cover estimate for standing litter. Because these values only represent the plots in which species occurred, however, the amount of cover is overestimated. By considering the cover values on the basis of the total number of plots samples (100), the general values for percent of plant cover are sagebrush/greasewood, 11.4 percent; juniper, 2.5 percent; shadscale, 9.6 percent and riparian, 15.3 percent. Individual species values are a part of the total and are generally very small except for the dominant species such as juniper, sagebrush, or Fremont poplar.

Plant density is a characteristic that is calculated by determining the number of plants per unit area. The density data reported in Tables IV-6 through IV-9 are based on the average number of plants in a $4m^2$ plot. Some typical plant densities in the sagebrush/greasewood are *Artemisia tridentata*, 5.1; *Chrysothamnus greenii*, 2.2; *Eurotia lanata*, 1.8; *Sarcobatus vermiculatus*, 1.9; and *Stipa comata*, 2.2. In the juniper type some typical densities are *Cryptantha*, 2.3; *Gutierrizia sarothrae*, 1.7; *Juniperus osteosperma*, 1.1; and *Hillaria jamesii*, 4.0. In the shadscale type *Atriplex confertifolia* has a density of 2.2; *Chrysothamnus greenii*, 3.2; *Grayia spinosa*, 2.3; and *Sitanion hystrix*, 1.2. Densities of understory species in the riparian type indicate a large number of plants in a given area. *Agropyron smithii* had a density of 13.8/plot; *Distichlis spicata stricta*, 53.4; and *Comandra pallida*, 32.3. The overstory of Fremont poplar in the White River flood plain is considered dense at 2.5 plants per plot. In terms of the total number of plots per samples (100), however, the density of Fremont poplar is 0.14 plants per $4m^2$.

Adequacy of sampling in terms of statistical reliability is a requirement of the baseline study. This requirement is realistic, however, only in terms of the dominant (and frequently occurring) plant species. For example, in the sagebrush/greasewood vegetation type, 136 *Artemisia tridentata* plants were measured for height. Because this is a relatively uniform characteristic the mean height of 29.2 cm varied from 27.3 cm to 31.1 in 90 percent of the cases. To adequately sample sagebrush height within

25 percent of the mean at a 90 percent statistical reliability, 12.9 samples would be required. Thus, the 136 observations made were an adequate sample. In terms of cover, 64 plots sampled contained sagebrush. The mean cover of sagebrush was 2,395 cm^2, with a 90 percent confidence interval about this mean ranging from 1,941 to 2,850 cm^2. Under these conditions 52.4 samples would be required to estimate within 25 percent of the mean with a statistical reliability of 90 percent. In terms of density, 64 plots out of 100 contained sagebrush with an average density of 5.1 and a confidence interval ranging from 3.8 to 6.5. Because of greater variability in density, possibly from a plant aggregation effect, 99 plots would be required for statistical adequacy and are clearly not provided.

The adequacy problem is not even considered when only one or two plants of a species are counted. Such a small sample does not provide enough information for statistical calculations.

Species encountered with high variability such as Eurotia lanata (the name has recently been changed to Ceratoides lanata) provide an example of the sampling dilemma. Within the 100 plots sampled in the vegetation type, 8 measurements of Ceratoides were recorded but 9 would be required for statistical adequacy. On 6 plots cover estimates were made but the cover was so variable among plots that 37.5 plots would be required for statistical adequacy. The density of Ceratoides was counted on 6 plots but 25 would be required to adequately describe the occurrence of the plant.

It would appear that within the limits of practicability only the dominant and regularly occurring species can be sampled with any degree of statistical reliability.

Foliage samples, which were supplied by Dr. C.M. McKell of the Utah State University, were collected from the northeast corner of Section 11, adjacent to Tract U-b. Samples of shadscale, greasewood and sagebrush were obtained in order to determine if a difference exists between biological species. The samples were analyzed with a high resolution GeLi gamma ray spectrometer and for Strontium-90 and Radium-226. The analyses show that no activities above normal background levels were measured, with Ra^{226} activity at 0.02-0.04 pCi/g, Sr^{90} below 19 pCi/g, Cs^{137} below 0.62 pCi/g and Ce^{144} below 5.3 pCi/g.

2. TERRESTRIAL VERTEBRATES

a. Big Game Telemetry Program

During the quarter of September-November 1975, movements of the radio collared deer on the Oil Shale Tracts were monitored to determine areas of utilization and movement patterns. With a few exceptions, the deer maintained a pattern of high utilization on the White River riparian area and the uplands immediately adjacent to it. During September, a tendency for deer to remain on the White River for long periods of time, as exhibited during the summer, was less evident. On several occasions, deer could not be found for several days, then would reappear on the river in the same area where located previously. With increased sign of deer in canyons leading away from the river, indications were that deer were using upland areas more than in the summer season. This pattern was maintained until the beginning of the deer hunt in late October. During the hunt, deer apparently left the riparian area and moved into the broken upland canyons because of high hunter pressure on the river bottoms. This was supported by poor success in locating deer during the hunt, and reports by hunters of deer moving off the river.

With the end of the deer hunt in late October, collared deer again set up residency on the White River. Sightings were frequent and consistent during this period (11-1 to 11-30) with the exceptions of the two buck deer collared. Deer .01 was not located, and deer .07 was last located on 10/28/75. It is not known at this time if either deer was harvested, or if a movement occurred because of initiation of the rutting season.

A roadblock was held the first weekend of the deer hunt to obtain hunter success and kill figures for the tracts. In checking deer hunters on the tracts during October, information obtained indicates the following items:

1) The tracts are more popular hunting areas than was originally assumed by the investigator. A total of 58 hunters were contacted who had spent all or part of their hunt in the area of the tracts and on the White River from Cowboy Canyon to Asphalt Wash.

2) Hunter success for the first weekend was at least as good as for the higher elevation areas of the Book Cliffs (15.6 percent for the Tract-White River area versus 13.5 percent for the higher elevations).

3) A minimum of 10 deer were killed in the Tract-White River area. Age structure of the kill was as follows: six yearlings; one 2-1/2 year old; three mature bucks. Ages were determined using the tooth wear and replacement method.

4) Several large camps concentrated their hunting in the Cowboy Canyon-Bonanza Bridge area. They reported seeing large numbers of deer on the river, but no collared deer. With the subsequent knowledge that .05 and .06 are still in that area, this would indicate a large population in this area, perhaps larger than was expected previously.

Doe-fawn classifications were recorded for deer observed during September and October. A sample of 87 deer was classified, with a ratio of 85 fawns/100 does obtained. This compares very favorably with the figure of 72 fawns/100 does obtained (unpublished) by the Division of Wildlife Resources personnel for the remainder of Unit 28A. For at least 1975, the tract area appears to be a very productive deer area. During the month, a total of 14 days were spent wholly or in part in obtaining deer data for the tract area.

b. Predator Telemetry

A trapline containing a line of ten traps was maintained throughout the quarter in an attempt to collar coyotes and bobcats. No success was achieved in this program as signs were still scarce throughout the tracts, and hunters reported seeing only one coyote near the mouth of Evacuation Creek and two in the Rainbow area south of the tracts.

A young bobcat kitten (less than a month old) was observed at the Evacuation Creek bridge. The animal was emaciated, indicating that it was orphaned. A mature bobcat was sighted at Asphalt Wash by VTN personnel November 20. One observation was made of a badger near X-9 on a night survey in September.

An indication of the low numbers of predators present was obtained during the fall deer classification work. Evacuation Creek was walked from Watson to the White River after a fresh snowfall in October. A total of three fresh coyote tracks were observed during this field walk-over.

c. Game Animals

Two observations were made of antelope in areas adjacent to the tracts. One was of 21 animals in the SW-1/4 of Section 21, 1-1/4 miles due north of F-5 in Asphalt Wash, on November 4. The other was of 42 animals 1 mile NE of A-3 on December 5. (This observation is included because of its proximity to the end of the quarterly period.)

During September, dove populations on the tracts maintained a high level. Dove hunters were contacted both on-tract and in the areas around Bonanza to determine harvest data for this area. A total of 16 hunters were contacted, with a total bag of 121 birds. Total hunter-days were 18. Bag per hunter-day was 6.7 birds. This figure was weighted heavily by a heavy harvest on the opening days when many bag limits of 10 birds were observed. Hunters were observed on the tracts in Southam and Asphalt Canyons. However, the great majority of birds harvested came from the area around Bonanza.

The age structure of the harvest was as follows:

73	juveniles
48	adults
1.52	juvenile/adult ratio

The figure of 1.52 juveniles/adults indicates a rather poor reproductive success for mourning doves in this area in 1975. This can be correlated with the late, cold, wet spring experienced this year.

d. Waterfowl

During this quarter, the Canada goose population which summered on the White River left the area. Between September and November, no geese were observed on the river during float trips, airplane flights, or on-the-ground surveys. It is strongly felt that these birds move down the White River to the Ouray area where large crops of grain are maturing at this time of year. Large numbers of Canada geese appear in this area yearly at this time. Absolute evidence of this movement, however, is not available.

Other waterfowl on the river during this quarter include large numbers of blue and green-winged teal in September during their migration, and a group of American mergansers. On October 13, a group of sandhill cranes was observed

heading south at the Evacuation Creek Bridge. It was estimated that a minimum of 300 birds were present in three flocks.

e. Raptors

Observations of raptors during the quarter included Cooper's hawks, sharp-shinned hawks, golden eagles, great horned owl, short eared owl, a prairie falcon, kestrels, and red-tailed hawks. Rough-legged hawks were not observed; this was especially unusual for November, when the birds should have been arriving in numbers from northern areas.

f. Avifauna

Terrestrial vertebrate data collected during October reflected the beginning of the cold weather season (Table IV-10). Several migratory breeding species present in June and August were gone from the tracts by October. Some other species were beginning to enter hibernation. Many permanent residents, however, were well represented on the tracts; and several wintering species had entered the area since August.

Forty-two species of birds were recorded in October, compared to 56 species in August. The number of avian species was greatest in riparian habitat (27 species), followed by greasewood (21 species), juniper (20 species), and shadscale (16 species). The total number of individuals recorded during transect walks was 559, down from a total of 838 in August. The decrease in the numbers and species of birds from August to October was attributed to the departure of many summer residents (e.g., several species of flycatchers, swallows, warblers; certain species of sparrows; the majority of mourning doves). This reduction in bird numbers was partially offset by the arrival of some winter residents on the tracts (e.g., dark-eyed juncos). Large flocks of horned larks, pinyon jays, and dark-eyed juncos were seen.

g. Mammals

Sixteen species of mammals were recorded on the tracts in October (Table IV-11). Fewer mammalian species were in shadscale habitat (5 species) than in greasewood (9 species), juniper (11 species), or riparian (10 species).

TABLE IV-10

TRANSECT OBSERVATIONS-AVIFAUNA[1/]

Bird (Order/Species)	October 1975 Vegetation Type G	J	S	R
Falconiformes				
Marsh Hawk	+	-	0.1	-
Cooper's Hawk	-	-	-	-
Red-tailed Hawk	+	-	+	-
Golden Eagle	0.3	+	+	-
Prairie Falcon	+	+	+	+
American Kestrel	0.1	+	+	-
Gruiformes				
Sandhill Crane	-	-	-	+
Columbiformes				
Mourning Dove	+	+	+	0.5
Strigiformes				
Great Horned Owl	-	-	-	0.1
Coraciiformes				
Belted Kingfisher	-	-	-	+
Piciformes				
Downey Woodpecker	-	-	-	0.2
Yellow-bellied Sapsucker	-	-	-	0.8
Common Flicker	-	+	-	0.4
Passeriformes				
Horned Lark	2.0	0.3	11.4	2.2
Barn Swallow	-	-	0.4	-
Black-billed Magpie	0.5	0.2	+	0.9
Common Raven	-	-	+	-
Clark's Nutcracker	-	0.6	-	-
Pinyon Jay	9.9	3.1	-	-
Plain Titmouse	0.2	0.3	-	-
Black-capped Chickadee	-	-	-	+
Common Bushtit	-	-	-	+
Rock Wren	0.6	0.3	0.1	-
Sage Thrasher	+	-	+	-
Townsend's Solitare	-	-	-	0.4
Swainson's Thrush	-	-	-	+
American Robin	-	-	-	0.1
Mountain Bluebird	0.1	1.1	+	-
Ruby-crowned Kinglet	-	+	-	0.1
Loggerhead Shrike	+	-	0.2	-
Western Meadowlark	0.1	-	0.9	+
Brewer's Blackbird	-	-	-	0.1
House Finch	-	0.1	-	-
Pine Siskin	-	-	-	+
Lark Sparrow	0.5	0.1	-	-
White-crowned Sparrow	0.2	+	-	+
Tree Sparrow	-	-	-	+
Chipping Sparrow	0.1	0.4	-	+
Dark-eyed Junco	0.4	0.4	-	4.8
Sage Sparrow	0.9	0.1	0.9	+
Song Sparrow	-	-	-	+
Rufous-sided Towhee	0.1	-	-	1.1
Unidentified (Passeriformes)	0.1	0.2	-	1.6

1/ Birds observed on or within 1.6 Km (1 mile) of Utah Oil Shale Tracts.
G = greasewood; J = juniper; S = shadscale; R = riparian
Figures = mean number of individuals observed per Km of transect walks (an index to density); + = observed but not on transect walks (i.e., present but rare); - = not observed.

TABLE IV-11

TRANSECT OBSERVATIONS - MAMMALS[1])

Mammal (order/species)	October 1975 Vegetation Type G	J	S	R
Chiroptera				
Bat (unidentified species)	+	+	-	-
Carnivora				
Badger	-	-	-	+
Coyote	-	+	-	+
Rodentia				
Whitetail Antelope Squirrel	1.0	-	0.4	-
Golden-mantel Squirrel	+	+	+	+
Colorado Chipmunk	-	0.1	-	+
Whitetail Prairie Dog	-	-	+	-
Apache Pocket Mouse	+	+	-	+
Ord Kangaroo Rat	+	-	-	-
Deer Mouse	+	+	-	+
Pinyon Mouse	-	+	-	-
Desert Woodrat	+	+	-	-
Porcupine	-	+	-	+
Lagomorpha				
Desert Cottontail	2.1	2.4	1.0	2.4
Artiodactyla				
Mule Deer	+	+	+	1.5
Domestic Cattle	-	-	-	5.5

1) Mammal observed on or within 1.6 Km (1 mile) of Utah Oil Shale Tracts. Mammal trapping results are not included.

G=greasewood; J=juniper; S=shadscale; R=riparian
Figures=mean number of individuals observed per Km of transect walks (on index to density); t=observed but not on transect walks (i.e., present but rare or infrequently observed);
-=not observed.

Total numbers of individual diurnal mammals recorded on transect walks were similar in August and October (110 and 112 respectively, exclusive of domestic livestock). These numbers represent an increase of about 40 percent since June. This was caused by the recruitment of young during the summer. October population levels were relatively high because mortality had not yet exerted an important effect upon the population gains made during the reproductive season. Conversely, numbers of individual rodents decreased steadily from 25 captures on the average per 100 trap nights in June to 21 captures in August to 17 captures in October (Table IV-12). This pattern can be attributed to relatively early recruitment and rapid development of young in small rodents as compared to larger mammals, coupled with high mortality rates in rodent populations.

h. Reptiles and Amphibians

Reptiles and amphibians showed a decline in total numbers and in species numbers from August to October (Table IV-13). Ten species (all reptiles) were recorded on the tracts in October, whereas 16 species (4 amphibians and 12 reptiles) were recorded in August. Species numbers in October were greater in juniper habitat (7 species) than in other habitat types. Reptiles and amphibians observed during transect walks on warm days in October decreased more than 50 percent compared with August transect walks; and on inclement days did not appear above-ground. October was the end of the active season for reptiles and amphibians on the tracts.

Snake observations for October were added to the existing data, completing data collection for 1975. The results of these observations were as follows:

	Vegetation Type			
	Riparian	Sagebrush-Greasewood	Shadscale	Juniper
Wandering Garter Snake	1	0	0	0
Desert Striped Whipsnake	0	0	1	1
Great Basin Gopher Snake	1	1	1	1
Midget Faded Rattlesnake	0	1	0	0

TABLE IV-12

RODENT TRANSECT TRAPPING PROGRAM[1)]

	October 1975 Vegetation Type			
	G	J	S[2)]	R
Rodent (species)				
Colorado Chipmunk	-	0.8		
Apache Pocket Mouse	10.0	5.8		1.7
Ord Kangaroo Rat				
Deer Mouse	10.8	3.3		9.2
Pinyon Mouse		0.8		
Desert Woodrat	1.7	3.3		

1) Number of rodents captured within rodent trapping transects on sampling site
G=greasewood; J=juniper; S=shadscale; R=riparian
Figures=mean number of captures made per 100 trap nights (an index to density)
-=no captures

2) Inclement weather precluded trapping in shadscale

TABLE IV-13

TRANSECT OBSERVATIONS - REPTILES AND AMPHIBIANS[1]

	October 1975 Vegetation Type			
	G	J	S[2)]	R
Amphibian (order/species)				
None	-	-	-	-
Reptile (order/species)				
Squamata				
Eastern Fence Lizard	-	0.8		0.3
Sagebrush Lizard	0.8	1.8	+	-
Tree Lizard	-	0.3	-	-
Side-blotched Lizard	0.8	2.6	+	0.5
Western Whiptail	-	0.3	-	-
Unidentified (lizard)		0.8		
Short-horned Lizard	-	-	+	-
Striped Whipsnake	-	+	+	-
Gopher Snake	+	+	-	+
Western Terrestrial Garter Snake	-	-	-	+
Western Rattlesnake	+	-	-	-

1) Reptiles and amphibians on or within 1.6 Km (1 mile) of Utah Oil Shale Tracts
G=greasewood; J=juniper; S=shadscale; R=riparian
Figure=mean number of individual observed per Km of transect walks (an index to density); t=observed but not on transect walks
(i.e.; present but rare; -=not observed

2) Inclement weather precluded walking transects in shadscale

3. TERRESTRIAL INVERTEBRATES

The following photographs, taken by Bradley Nelson (University of Utah Medical School Photo Lab.), illustrate some of the more conspicuous arthropods in the oil shale tracts and the methods for capturing arthropods (Figures IV-2 and IV-3).

4. AQUATIC BIOLOGY

a. Plankton

Plankton was sampled with a hand plankton net and an alpha sampler (Quarterly Report No. 4, Figure IV-12). During this sampling period phytoplankton density was several times greater than in earlier measurements. Algal concentration averaged nearly 79,000 cells or filaments per liter, compared to earlier ranges of 7,800 to 19,500 cells per liter. The increased phytoplankton density is attributed to the prolonged period of "normal" flow in the river. During low flow, suspended solids are reduced and transparency is relatively high. The abundant light permits efficient photosynthesis and rapid reproduction by the algae. Plankton concentrations are shown in Table IV-14. These counts are probably near the maximum that will be encountered in the White River. The short days and reduced water temperatures occurring in late autumn reduce algal growth rates and slow reproduction. The present high population levels will be reduced by animal grazing and later by spring floods (Hynes 1970). The high growth rate necessary to reestablish the dense algal community will not occur until next summer after spring runoff recedes, transparency improves, and water temperature increases.

The species composition of the algal community collected was similar to earlier samplings. *Cladophora glomerata* is the most common filamentous alga. *Spirogyra* sp. and *Ulothrix* sp. appear less frequently, along with the blue-green *Anabena* and *Phormidium* spp. Mats of *Vaucheria* sp., a yellow green alga, occur, but are apparently confined to the left bank at Station F-1. The planktonic algal community is dominated by diatoms. Most of these grow as periphyton on submerged stones, or as epiphytes on attached algae. The diatoms found free of attachment are among the plankton. During late September there was no clearly dominant species. *Cocconeis placentula*, which has been predominant in some of the past collections was abundant, together with the co-dominants *Navicula* spp.,

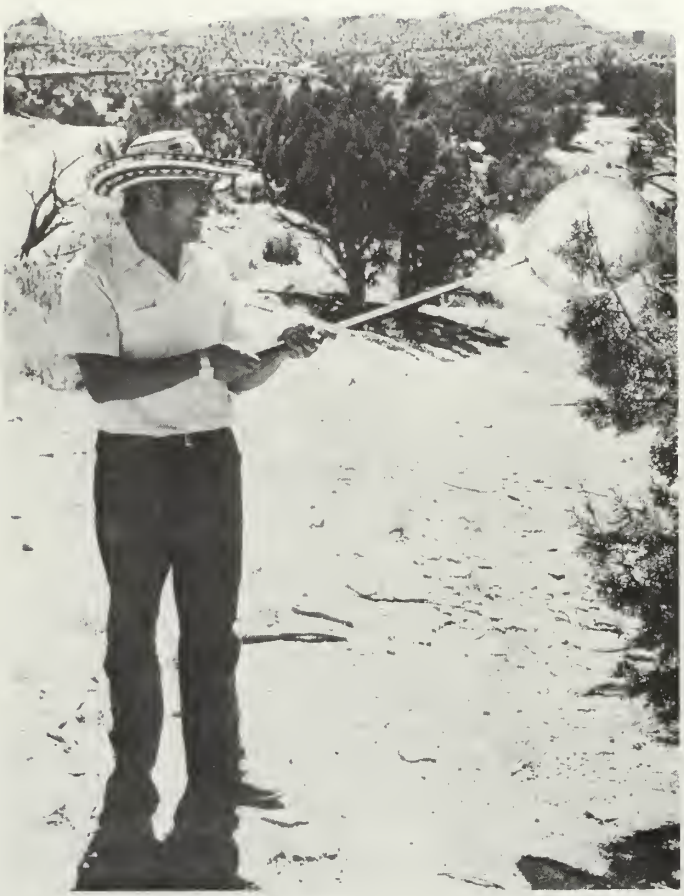


FIGURE IV-2

TERRESTRIAL INVERTEBRATE COLLECTION METHODS

"Sweeping" juniper in upland belt. Fifty sweeps per sample.

"Malaise" trap located over gully (insect flyway). Insects contact center partition, move upward to ridge, upward along ridge to cyanide bottle.

Scorpion (undetermined). Abundant under flat stones by "duck" formation. Feed on medium-sized to large arthropods. Forage at night.

Black widow spider female (Latrodectes sp.) Ventral side, showing "hour-glass" marking. Common under flat stones in sheep drive areas. Feed on arthropods entering web and within several inches.

FIGURE IV-3
ARTHROPOD PHOTOGRAPHS

Snowy tree cricket (Oecanthus) on rabbit brush. Evening song. Feeds on petals and leaves. Very abundant near stream courses.

FIGURE IV-3
(CON'T)

Striped locust (Melanoplus bivattatus) mating pair on rabbit brush. Commonest grasshopper in more densely vegetated areas.

Orb spider (Araneus sp. male). Large pedipalps and long front legs denote males (which don't make orb webs).

FIGURE IV-3
(CON'T)

Wolf spider (Lycosa sp. female). This species forages by day on sand along stream courses. Does not spin web except to line hole.

Robber fly (Promachus aldrichii) with grasshopper (Melanoplus sp.) prey.

FIGURE IV-3
(CON'T)

Green lacewing (Chrysopa sp.) Adults and larvae feed on aphids and other soft-bodied insects. Eggs provided with long stalks.

TABLE IV-14

PLANKTON CONCENTRATION

Station	Location	Count
F-1	White River	63,300 cells per liter*
F-2	White River	87,300 cells per liter
F-3	White River	111,000 cells per liter
F-4	White River	51,400 cells per liter
F-5	White River	79,300 cells per liter
Average	White River	78,500 cells per liter
F-6	Evacuation Creek	143,000 cells per liter

*Average of 12 counts on 3 sub-samples

Nitzschia spp., and Gomphonema olivaceum. Cylindrotheca gracilis was the most abundant diatom in Evacuation Creek. Prescott (1970) states that this unique genus has apparently not been reported in the United States; however, Rushforth (pers. comm.) reported it in an ephemeral pool in Asphalt Wash.

b. Periphyton

As discussed in Section IV.A.4, efforts to collect quantitative periphyton have been impaired by difficulties with sampling devices. Qualitative collections were made by scraping rocks and other submerged articles. Dominant species were the same as encountered in the plankton samples.

c. Macroinvertebrates

Invertebrate population in the White River was dense and diverse in late September. Nymphs of the mayfly Traverella albertana were large and abundant. Adults of this species emerged almost continuously during field work. Heptagenia elegantula, Pseudocloen turbidum, Dactylobaetis cepheus, Ephemerella sp. and Baetis sp. were also common or abundant, but other species had apparently completed their emergence. Only a few specimens of Ephoron album, Choroterpes albiannulata, and Lachlania saskatchewanensis were detected ready for emergence, or as molted exoskeletons (exhuviae). Several species appeared in the September collection for the first time during this study, including Ephoron album, Choroterpes albiannulata, Dactylobaetis cepheus and Trichorythodes minutus. The abundance of species and individuals, along with evidence of species no longer present, indicated that early to mid-September would be an ideal time to study the White River mayfly population.

Hydropsyche sp. was the only common caddisfly larvae. Leptocella sp., which had been common during July, apparently emerged before the September sampling. Their cases were common, but few contained living larvae.

Most stoneflies spend the summer in the egg stage, or as small nymphs. These forms are too small for capture with Surber samplers and are seldom detected. Isogenoides frontalis colubrinus is probably the most common stonefly in the White River. Only a few small nymphs were collected. Oemopteryx fosketti become abundant in the early winter and emerge in February. None were detected in September.

Table IV-15 provides a summary of Surber collection data. The average Surber sample (1 ft^2 or 0.093 m^2) contained 145 invertebrates (1,563/m^2). This compares to average square foot hauls of 23 (October, 1974) 13 (April, 1975) and 6 (July, 1975). The relatively large numbers of invertebrates encountered are almost certainly a seasonal phenomenon. Of approximately 3,600 total organisms taken in the Surber sampler, over 3,000, or almost 85 percent were mayfly nymphs. Traverella albertana was clearly the most abundant species. The life history of this insect illustrates the reasons for the fluctuating population density among aquatic insects. Traverella albertana has a life cycle referred to as univoltine; i.e., one generation is produced per year. The adults emerge during October, deposit eggs in the stream, and die. The eggs adhere to stones and may not hatch for several months. In the case of other insects, the eggs hatch soon but the insect spends much of the year as a minute nymph. The eggs and small nymphs pass through most collecting devices and are not detected. At some time during summer, the nymphs quickly mature and emerge to begin the life cycle once more (Hynes, 1970). This phenomenon results in fluctuating numbers of total organisms and the number of species present. During this study 4 mayfly species were observed in April, 10 in July, 13 in September, and 7 in October. Stonefly populations follow a similar cycle; however, they mature during winter and early spring. The difference in timing reduces competition between different taxa and tends to decrease fluctuations in the total number of invertebrates that may be observed at any time. Other groups of aquatic insects produce several generations per year. Their waxing and waning tends to complicate and obscure overall population fluctuation trends.

This sampling indicated that the density of invertebrate populations was far greater than before, but that it fell short of findings by Bauman et al. (1975). Bauman found 854 organisms per sq ft (9,192/m^2) at Station F-1 and 696 (7,492/m^2) at Station F-3 (Bauman's Stations S-3 and S-4). The relative abundance of the different taxa found generally agree with the results of this study.

Table IV-15 shows a considerable difference between samples at some of the stations, particularly F-4 and F-5. The different numbers reflect changes in habitat, but are contradictory. Figure IV-4 shows a shallow riffle approximately 175 m downstream from the gaging station at F-4. Samples 1, 2, and 3 were collected as shown by the numbers. Samples 4 and 5 were collected at points shown in Figure IV-5 from an area of coarse shale substrate (15/cm diameter). The large stones near shore had a much greater density of

TABLE IV-15

SUMMARY OF SURBER COLLECTION DATA
(Invertebrates/ft2)

	F-1					F-2					F-3					F-4					F-5					
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	TOTAL
EPHEMEROPIERA																					6	11	104	54	21	789
																					1	1	3	7	7	266
Heptagenia elegantula	19	52	19	44	21	42	6	39	23	68	21	42	22	29	17	2	2	5	61	59				1		35
Rhithrogena undulata	9	8	3	14	22	24	34	8	12	4	7	9	29	1	46		7	10								6
Baetis Sp. A	3	2		3	6	2	2	3	4	4			2		1					2	2					45
Baetis Sp. B										5									1		3	13	6	22	9	482
Dactylobaetis cepheus	6	3		3	4		2	4		4	2	4		1				1	5	4						17
Pseudocloeon turbidum	24	9	1	7	9	70	36	21	20	19	19	23	38	27	32	1		2	42	29	12		65	224	63	1181
Lachlania saskatchewanensis				4	11	1												1			1					13
Traverella albertana	9	33	10	122	136	5	18	11	49	68	28	45	76	30	74	16	5	13	23	46		1	2	7		118
Choroterpes albiannulata						1			4		1									6	1	1		8	3	58
Ephemerella (inermis?)	17	11		9	21	7	4	7	3	17			6	3	3											3
Trichorythodes minutus	1			2	1	4		5	2	1	4	4	3	2	1	13				2						
Trichorythodes edmundsi													1							2						
ODONATA																					2		1	3	2	31
																										1
Ophiogomphus severus		1		2	4	2		2		2			3				1		2	4						
Hetaerina sp.																			1							
PLECOPTERA																					5		4	3		42
Isogenoides frontalis	2				12		3		1		2		5	1	1	1		1	1	1						
TRICHOPTERA																						5	7	7	1	391
																							1			1
Hydropsyche sp.	4	5	4	3	19	66	5	9	74	54	10	4	56	14	34	1			7	2		5	1	1		16
Brachycentrus sp.																										
Leptocella sp.													1													
PIPTERA																							1	2		46
																								1		6
Chirohomidae	2	1	2	4	9	2	3		5	6	1		4						2	2						5
Chironomus sp.										2		2		1												4
Orthocladius sp.								2						3												
Crictopus sp.															4											
Hexatoma sp. (Tipulidae)																2										2
Ephydridae							1						1									1				3
Ceratopogonidae													1													1
Empididae										1																1
Simuliidae	1			6	2		3	3	7				9		4	3										38
PLESIOPORA (Annelida)																										
Limnodrilus claparedianus						2	1	1	2																	6
Naididae							1						1	2						2	1					5
NEMATODA													1													1
TOTAL/ft^2	97	125	39	225	281	228	118	115	208	255	95	133	259	114	217	38	16	32	149	164	34	38	195	340	103	3613
TOTAL/m^2	1047	1350	421	2430	3035	2462	1274	1242	2246	2754	1026	1436	2797	1231	2343	410	173	346	1604	1771	367	410	2106	3672	1112	38,891

invertebrates than the shallow riffle. The situation was somewhat reversed at Station F-5 (Figure IV-6). The shallow riffle (Samples 4 and 5) at this point had an abundant invertebrate fauna, composed of the same general taxa as the riffle at F-4. The substrate was similar at both riffles.

The results are unsuitable for statistical analysis because of the variation in capture success. The following data were calculated from Table IV-15 using the methods of Weber (1973) and Slack et al. (1973).

	(sum of samples)	= 3618
$\bar{X}$	(mean sample size)	= 145
S^2	(variance)	= 8021
S	(standard deviation)	= 89.56
$S\bar{X}$	(standard error)	= 17.9
$\bar{X} \pm$	(t) ($S_{\bar{x}}$) (95% confidence level)	= 145 ± 37

These data indicate that 95 percent of the samples could be expected to fall within the range of 108 to 182. Examination of Table IV-15 will show that only 7 of the 25 samples are within this range.

Population information developed by Surber sample data are summarized in Table IV-16. Increases over previous conditions in this study are shown in the species diversity, the overall number of organisms, and the number of taxa present. These conditions are all thought to result from the temporary abundance of mayfly nymphs.

Data from Tables IV-15 and IV-16 suggest that statements made earlier in this study regarding productivity of the White River should be re-examined. Madsen (1935) graded productivity of streams according to the average numbers of bottom organisms. Streams with less than 1,076 organisms per square meter were graded as poor, those with 1,076 to 2,152 per square meter as average, and those with more than 2,150 per square meter as rich. Fishery researchers have used this system for many years (Pennak, 1975).

Surber sample data from September 1975 averaged 1,566 organisms per square meter (Table IV-17). According to the Madsen system, the stream could be classified as average. Pennak (1975) sampled the White River above and below the confluence of Piceance Creek in Colorado. He found a maximum of 1,048/m^2 on October 20. Bauman et al. found over

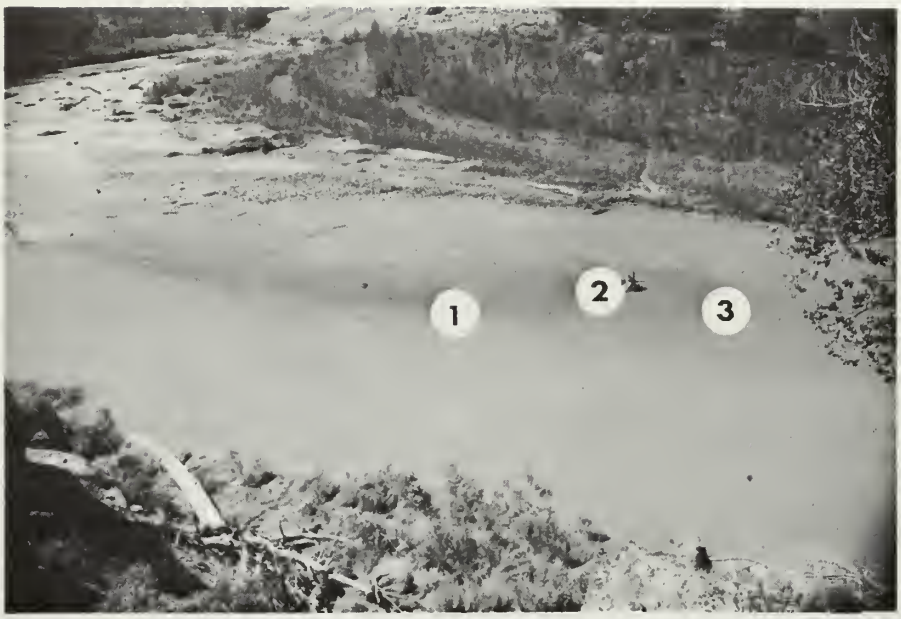


FIGURE IV-4

RIFFLE DOWNSTREAM OF F-4
(NUMBERS SHOW LOCATION OF SURBER SAMPLES)

FIGURE IV-5

STATION F-4 (NUMBERS SHOW LOCATION OF SURBER SAMPLES)

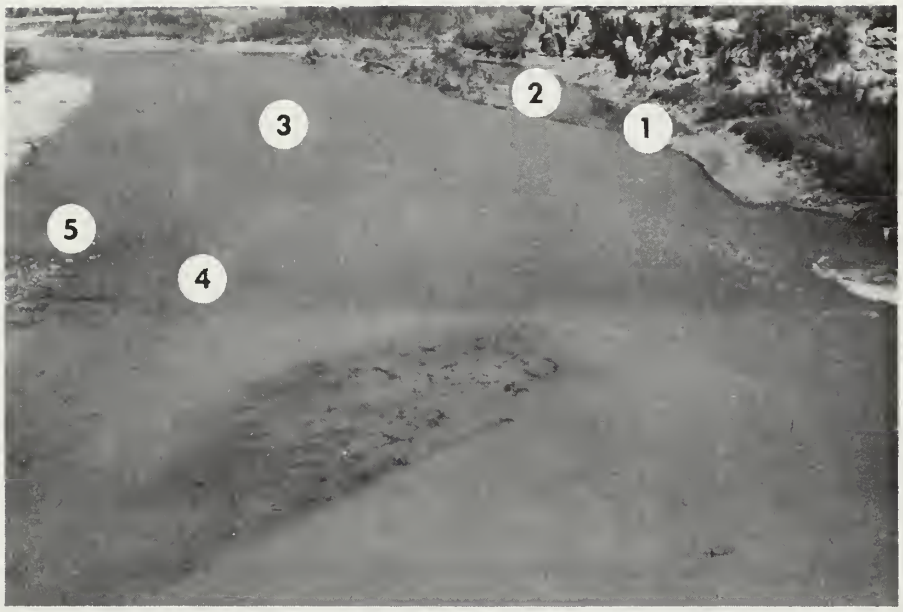


FIGURE IV-6

STATION F-5 (NUMBERS SHOW LOCATION OF SURBER

TABLE IV-16

SPECIES DIVERSITY INDICES OF BENTHIC INVERTEBRATES
BY SHANNON-WEAVER FUNCTION
(September, 1975)

Station	Sample #	SDI	N*	Y**
F-1	1	3.00	97	12
	2	2.55	125	10
	3	1.99	39	6
	4	2.31	225	14
	5	1.50	281	15
F-2	1	2.52	228	13
	2	2.62	118	14
	3	3.02	115	12
	4	2.78	208	15
	5	2.76	255	14
F-3	1	2.66	95	10
	2	2.30	133	8
	3	3.13	259	18
	4	2.59	114	11
	5	2.53	217	12
F-4	1	2.07	38	7
	2	1.92	16	5
	3	2.03	32	7
	4	2.23	149	10
	5	2.54	164	14
F-5	1	2.77	34	10
	2	2.37	38	8
	3	1.77	195	11
	4	1.79	340	13
	5	1.54	103	7
Average		2.37	145	11.3

* = Number of invertebrates per square foot (0.093 meter^2)

** = Number of taxa per sample

6,000 organisms per sq ft near the Bonanza Bridge (VTN Station F-3) during early September. The variation in these figures indicate that many factors should be considered before basing a stream classification on bottom fauna density. This fact is supported by data presented in earlier quarterly reports. The data indicate that the White River invertebrate fauna range from scarce to abundant, depending on where, and more importantly, when measurements are taken.

Organisms which dwell in silty areas or areas where the substrate is soft are sampled with the Ekman dredge. Results obtained by this method directly contradict the increased productivity shown by Surber samples. Table IV-18 shows results of Ekman sampling. Seven or more samples were taken at each station in an effort to locate habitats where organisms were more abundant. As shown by Table IV-18, only a few samples contained any organisms. The average of less than 100 organisms per square meter was far below past results. Fly larvae of the family Chironomidae are usually common to abundant in many of the silted areas. Only a few could be found in September. A stagnant backwater at Station F-4 in April 1975, harbored a dense population of the tubificid worm *Limnodrilus claparedianus* (8,300± per m^2). Only a few specimens were found in September.

d. Fishery

Fish collection was attempted unsuccessfully with 6 m (20 ft) seine and minnow traps. Limited success was achieved with the handled section of a windowscreen that is used primarily for collecting insects. This device is particularly effective for collecting speckled dace (*Rhinichtys osculus*) in riffle areas that range in depth from 0.1 to 0.5 m. The large braided riffle at Station F-2 produced 20 speckled dace by this method on September 26, 1975. All were marked and released in the main channel. Approximately 200 m^2 of the riffle habitat shown in Figure IV-7 were fished using this method. The irregular bottom permits many fish to elude capture; however, the declining capture rate suggests that the 20 specimens taken represent a major portion of the population in the area fished.

The insect screen was also used effectively in a meander pool at the bend below the Bonanza Bridge. Twenty red shiners (*Notropis lutrensis*), two fathead minnows (*Pimepheles promelas*) and one roundtail chub (*Gila robusta*) were captured by this method. All were marked and released in the channel except for the roundtail chub (Figure IV-8).

TABLE IV-17

WHITE RIVER INVERTEBRATES PER UNIT AREA

Station	Sample No.	Organisms Per Square Foot	Organisms Per Square Meter
F-1	1	97	1047
	2	125	1350
	3	39	421
	4	225	2430
	5	281	3035
F-2	1	228	2462
	2	118	1274
	3	115	1242
	4	208	2246
	5	255	2754
F-3	1	95	1026
	2	133	1436
	3	259	2797
	4	114	1231
	5	217	2343
F-4	1	38	410
	2	16	173
	3	32	346
	4	149	1609
	5	164	1771
F-5	1	34	367
	2	38	410
	3	195	2106
	4	340	3672
	5	103	1112
Average		145	1563

TABLE IV-18

BOTTOM INVERTEBRATE SAMPLE DATA EKMAN DREDGE (SEPTEMBER, 1975)

Station	F-1			F-2			F-3			F-4			F-5		
Sample #	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Rhithrogena undulata															
Ophiogomphus serverus	1		1		4	1		2	4					1	
Chironomidae				1		1						1			1
Ceratopogonidae				1	1					1					
Simuliidae										1					
Limnodrilus claparedianus					5	1						3			
TOTAL	1	0	1	2	10	3	0	2	4	0	2	4	0	1	1

Average per 1/4 square foot (233 cm^2) = 2.1 organisms

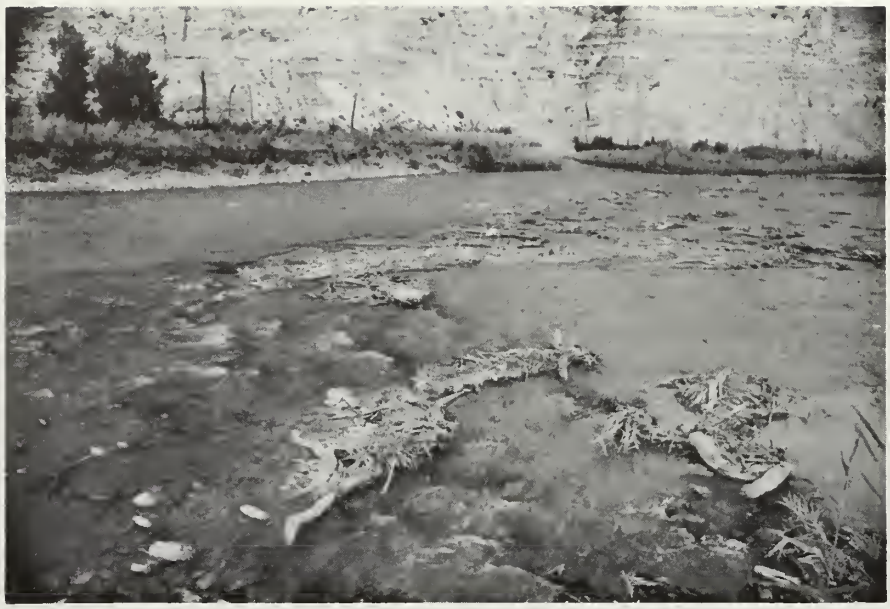


FIGURE IV-7

RIFFLE AT STATION F-2

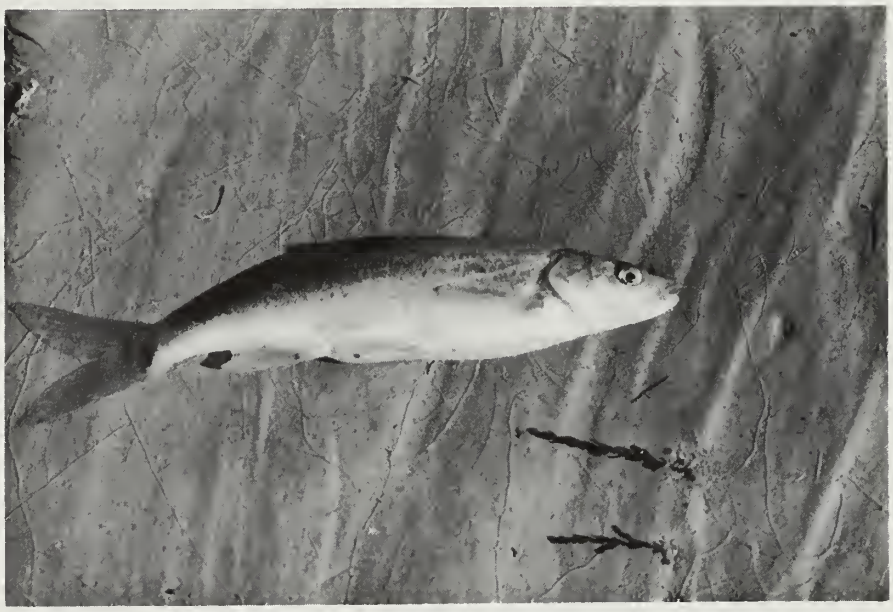


FIGURE IV-8

ROUND-TAIL CHUB

It was added to the reference collection. Total length of the specimen was 151 mm (7 in.). A minnow trap had previously failed to capture fish from the pool.

5. MICROBIOLOGY

The results from this quarter indicate that biological activities are generally decreasing through the late fall as the temperature drops.

Activities remain concentrated in the top layer of soils (especially litter samples) as would be expected and generally are somewhat greater in soils under canopy than interspace soils.

a. Microbial Numbers

Values for plate counts are shown on Table IV-19. The greatest numbers were normally found in the 0 to 3 cm depth at all sites with numbers ranging from 4.1×10^6 to 6.9×10^2 in the lower profiles. Several cases of higher values, however, were found in the 5 to 20 cm depth, compared to the surface layer, because of moisture and aeration factors. A general decrease in numbers from September through early November was evident.

Streptomycetes followed the same general decrease toward fall as the bacteria. The numbers were fairly consistent from station to station, however, and depth did not seem to affect numbers to any noticeable degree.

Fungi increased considerably at Station 50 J-L from September to November with all other sites showing a general decrease in October and subsequent rise again in November.

b. Dehydrogenase Activity

The determination of this indicator of biological activity is based on the ability of the soil to reduce triphenyltetrazolium chloride to the respective formazan. Thus, the rate of formazan formation represents total biological activity.

The greatest activity at all stations is evident in the surface litter representing a ten-to-twenty-fold difference

TABLE IV-19
MICROBIAL NUMBERS

	Aerobic Bacteria Number Per Gram of Soil			Anaerobic Bacteria Number Per Gram of Soil			Streptomycetes Number Per Gram of Soil			Fungi Number Per Gram of Soil		
Sample	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	3.0×10^6	1.3×10^6	3.2×10^6	2.1×10^4	1.5×10^3	1.2×10^4	1.6×10^6	5.5×10^5	1.3×10^6	2.2×10^4	2.14×10^4	8.8×10^3
39-2	6.0×10^5	5.7×10^5	3.4×10^5	6.7×10^2	1.8×10^3	1.2×10^3	2.7×10^5	2.2×10^5	1.5×10^5	5.6×10^3	6.6×10^3	2.8×10^3
39-3	1.1×10^6	4.6×10^5	8.8×10^4	6.9×10^2	2.2×10^3	1.0×10^3	3.7×10^5	1.3×10^5	1.0×10^4	6.8×10^3	4.2×10^3	1.0×10^3
50 J-I-1	4.0×10^6	4.1×10^6	3.3×10^6	1.1×10^4	1.3×10^4	1.0×10^3	4.0×10^6	2.5×10^6	2.5×10^6	2.1×10^4	2.8×10^4	2.8×10^4
50 J-I-2	-	-	-	-	-	-	-	-	-	-	-	-
50 J-L	1.0×10^6	-	1.4×10^6	9.9×10^4	-	2.4×10^4	1.0×10^6	-	4.4×10^5	6.5×10^3	-	2.5×10^5
50 J-C-1	2.96×10^6	2.1×10^6	1.7×10^6	3.7×10^4	7.2×10^3	1.2×10^4	2.96×10^6	1.6×10^6	1.0×10^6	3.0×10^4	2.6×10^4	2.7×10^4
50 J-C-2	-	-	-	-	-	-	-	-	-	-	-	-
55 R-1	6.5×10^5	5.4×10^5	6.2×10^6	5.7×10^3	1.4×10^4	1.3×10^5	1.3×10^5	2.8×10^5	1×10^6	1.5×10^4	4.0×10^4	2.2×10^5
55 R-2	1.14×10^6	1.7×10^6	-	5.8×10^3	8.0×10^3	-	1.6×10^5	3.0×10^5	-	1.1×10^4	2.3×10^4	-
55 R-3	9.5×10^5	4.8×10^6	3.7×10^6	1.3×10^3	5.2×10^3	7.0×10^3	2.1×10^5	6.8×10^5	1.9×10^5	3×10^3	7.6×10^3	6.2×10^3
58 1-1	4.7×10^6	1.54×10^6	1.04×10^6	5×10^3	1.8×10^4	5.7×10^3	1.3×10^6	1.5×10^6	5.6×10^5	5×10^3	4.6×10^3	1.4×10^4
58 1-2	1.2×10^6	9.8×10^5	7.3×10^5	5×10^3	6.2×10^3	2.3×10^3	2.8×10^5	3.96×10^5	3.3×10^5	7×10^3	1.8×10^4	1.6×10^4
58 1-3	1.9×10^6	1.12×10^6	6.1×10^5	1.7×10^3	7.2×10^3	2.0×10^3	3.7×10^5	4.3×10^5	2.5×10^5	4×10^3	4.4×10^4	1.14×10^4
58 C-1	3.7×10^6	-	1.3×10^6	7×10^3	-	3.1×10^4	1.4×10^6	-	7.4×10^5	2.98×10^4	-	2.96×10^4
58 C-2	1.02×10^6	-	5.2×10^6	1.8×10^4	-	8.0×10^3	3.4×10^5	-	2.2×10^5	2×10^4	-	1.30×10^4
58 C-3	9.3×10^5	-	2.8×10^5	2.5×10^4	-	2.7×10^3	4.0×10^6	-	1.3×10^5	1.2×10^4	-	7.4×10^3
39-L	-	-	-	-	-	-	-	-	-	-	-	-
55 R-L	-	-	-	-	-	-	-	-	-	-	-	-
58-L	-	-	1.4×10^6	-	-	6.0×10^3	-	-	2.2×10^5	-	-	2.9×10^4

in activity over the surface mineral soil layers. The surface (0 to 3 cm) soils were generally 100 to 200 percent more active than lower profile samples.

Station 39 showed a steady decrease in activity as the fall season began; however, while Stations 58 I, 50 J-I, 50 J-C, 55 R and 55 I showed a marked decrease for October samples, activity rose again in November to the approximate rates observed in early September. There was insufficient data for Station 58 C to make a report for the current reporting period. Results discussed above are listed in Table IV-20.

c. Proteolytic Activity

Proteolytic activity (protein hydrolysis) at station 39 corresponded with the general trend for dehydrogenase activity at the same site, showing a steady decrease throughout the fall months. Again, as with dehydrogenase activity, Station 58 I, 50 J-C and 50 J-I (surface layers) showed a decrease in October activity with an upward swing again in November.

Station 55 R showed a general increase in October receding to lower activity again in November. Litter and surface layers generally reflect highest values of proteolytic activity. The data are shown in Table IV-21.

d. Respiration

A significant decrease in respiratory activity occurred in October with Station 58 I showing essentially no activity. Station 55 R showed a general increase throughout the fall.

Carbon dioxide (CO_2) evolution was greater in soils under a canopy than in interspace soils (Table IV-22).

e. Water Potential

Data indicates considerably lower water potentials from September to October with an increase again in November at all stations, except 58 I which remained relatively constant (Table IV-23). Station 58 C soils showed a general reduction throughout fall, although no data for October are available. Biological activity trends for the most part tended to correspond to available water as expressed by its potential values in soils.

TABLE IV-20

DEHYDROGENASE ACTIVITY

Formazan mg/ml

Sample	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	.184	.074	.043
39-2	.048	.016	.010
39-3	.033	.035	.006
50 J-I-1	.421	.040	.220
50 J-I-2	-	-	-
50 J-L	1.223	-	.454
50 J-C-1	.775	.256	.477
50 J-C-2	-	-	-
55 R-1	.239	.119	.582
55 R-2	.068	.050	-
55 R-3	.028	.021	.035
58 I-1	.050	.009	.041
58 I-2	.018	.006	.018
58 I-3	.011	.009	.011
58 C-1	.218	-	.170
58 C-2	.127	-	.082
58 C-3	.034	-	.046
39-L	-	-	-
55 R-L	-	-	-
58-L	-	-	1.458

TABLE IV-21

PROTEOLYTIC ACTIVITY

% HYDROLYSIS

Sample	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	9.0	8.0	2.0
39-2	2.7	2.5	1.7
39-3	5.9	1.6	0
50 J-I-1	19.0	13.0	30.5
50 J-I-2	-	-	-
50 J-L	62.2	-	51.0
50 J-C-1	36.0	23.5	16.8
50 J-C-2	-	-	-
55 R-1	7.5	15.3	5.0
55 R-2	10.5	15.0	-
55 R-3	5.9	2.0	12.1
58 I-1	12.1	3.1	6.0
58 I-2	7.6	6.2	10.0
58 I-3	7.4	5.0	10.0
58 C-1	5.8	-	2.0
58 C-2	22.0	-	7.5
58 C-3	17.5	-	57.5
39-L	-	-	-
55 R-L	-	-	-
58-L	-	-	4.1

f. Soil Moisture Content and pH

The amount (percent) of moisture held in soil varied from station to station (Table IV-24), but showed a steady increase throughout the fall months, particularly in the top soil layers. The pH values of soils are shown in Table IV-25. High overall values are reflective of the arid soils in the area.

g. Nitrification Potential

Results (Table IV-26) show that the soils are generally capable of oxidizing added ammonium to nitrate, although the lag period tends to be 16 to 18 days under optimum conditions. In comparison, results of White River soils show little difference from garden soil using the current procedure. In the perfusion method, the garden soil nitrifies added ammonium at a much higher rate than the White River soils, which tend to follow the pattern of nitrification potential observed in desert soils (i.e., lag period of 16 to 18 days necessary for building up the nitrifying population).

h. N_2-Fixation

Values have been obtained and reported for April, May and July samples (Table IV-27). Increases occurred in Stations 55R and 39 from late April to May with a sizeable decrease at all other sites over the same period. Values of all stations continued a downward trend from late May to early July, except Station 50 J-C where levels rose significantly in July.

ATP Concentration

ATP concentration has been used as an index of microbial biomass; however, it could be used to indicate total biological activity in soil. Results (Table IV-28) show that concentration decreases with depth and is greater beneath the canopy than in the interspace. Values were relatively consistent throughout the period reported. Surface samples are analyzed monthly while samples below the surface layer are analyzed bimonthly.

TABLE IV-22

RESPIRATION

μmoles CO_2/g/min

Sample	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	5.78	3.95	17.70
39-2	5.29	.87	10.12
39-3	4.74	0	8.62
50 J-I-1	9.91	5.88	14.12
50 J-I-2	-	-	-
50 J-L	36.61	-	18.14
50 J-C-1	17.87	6.33	6.68
50 J-C-2	-	-	-
55 R-1	3.81	11.88	11.31
55 R-2	5.11	5.95	-
55 R-3	1.76	1.14	10.50
58 I-1	1.29	0	2.16
58 I-2	2.37	0	1.21
58 I-3	2.38	0	.64
58 C-1	4.12	-	8.98
58 C-2	1.34	-	9.25
58 C-3	2.38	-	.32
39-L	-	-	-
55 R-L	-	-	-
58-L	-	-	22.92

TABLE IV-23

WATER POTENTIAL
(During Respiration Studies)
-Bars

Sample	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	235.9	124.7	136.8
39-2	228.8	15.0	136.9
39-3	243.8	78.0	224.7
50 J-I-1	57.5	156.71	227.4
50 J-I-2	-	-	-
50 J-L	32.3	-	228.2
50 J-C-1	114.7	18.20	23.6
50 J-C-2	-	-	-
55 R-1	38.6	112.33	8.0
55 R-2	186.8	140.27	-
55 R-3	309.2	321.92	164.7
58 I-1	279.2	81.50	48.3
58 I-2	323.9	161.37	163.0
58 I-3	55.5	268.5	300.9
58 C-1	330.9	-	7.0
58 C-2	235.3	-	191.78
58 C-3	311.6	-	52.3
39-L	-	-	-
55 R-L	-	-	-
58-L	-	-	94.5

TABLE IV-24

SOIL MOISTURE CONTENT
% MOISTURE IN SOIL

Sample	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	4.79	11.46	24.23
39-2	5.42	8.53	7.11
39-3	4.98	7.51	8.30
50 J-I-1	14.20	9.99	13.99
50 J-I-2	-	-	-
50 J-L	31.17	-	9.83
50 J-C-1	10.44	14.95	8.66
50 J-C-2	-	-	-
55 R-1	8.23	12.44	21.29
55 R-2	4.11	5.91	-
55 R-3	3.21	3.35	5.67
58 I-1	6.75	9.75	12.17
58 I-2	2.89	7.42	8.79
58 I-3	3.41	6.21	5.85
58 C-1	2.98	-	10.90
58 C-2	2.99	-	7.07
58 C-3	3.46	-	6.14
39-L	-	-	-
55 R-L	-	-	-
58-L	-	-	13.16

TABLE IV-25

SOIL pH VALUES

Sample	12 Sept. 1975	6 Nov. 1975
39-1	8.50	8.80
39-2	8.40	8.60
39-3	8.40	8.80
50 J-I-1	8.00	7.40
50 J-I-2	-	-
50 J-L	7.95	7.10
50 J-C-1	8.15	7.50
50 J-C-2	-	-
55 R-1	8.20	8.30
55 R-2	8.20	-
55 R-3	8.15	8.10
58 I-1	8.60	7.70
58 I-2	9.35	7.50
58 I-3	9.70	7.40
58 C-1	9.40	8.40
58 C-2	9.40	9.40
58 C-3	9.30	9.60
39-L	-	-
55 R-L	-	-
58-L	-	7.60

TABLE IV-26

NITRIFICATION

μg N/DRY g
(Surface Samples Only)

Sample	25 April 75		*16 May 75		27 June 75		2 July 75		8 August 75		12 September 75		4 November 75	
	NH_4^+	$NO_2^-+NO_3^-$	NH_4^+	$NO_2^-+NO_3^-$	NH_4^+	$NO_2^-+NO_3^-$	NH_4^+	$NO_2^-+NO_3^-$	NH_4^+	$NO_2^-+NO_3^-$	NH_4^+	$NO_2^-+NO_3^-$	NH_4^+	$NO_2^-+NO_3^-$
39-1	142	9	29	23	80	0	75	138	26	56	179	44	49	25
50 J-C-1	6	31	0	25	52	14	89	74	150	0	196	10	105	19
50 J-I-1	0	21	0	0	0	28	74	7	155	10	191	49	87	6
55 R-1	0	106	0	13	9	98	2	138	19	19	131	0	1	41
58 I-1	47	0	0	7	29	54	96	6	71	4	65	0	32	23
58 C-1	-	-	-	-	-	-	0	67	118	20	100	0	-	-
Garden soil (control)	38	55												

*Incubated at 30°C

TABLE IV-27

NITROGEN (N_2) - FIXATION POTENTIAL

g N_2 FIXED/HA/24 HRS

Sample	April 25, 1975	May 27, 1975	July 2, 1975
39-1	23.30	222.30	72.12
50 J-C-1	21.40	7.61	227.14
50 J-I-1	59.02	-	5.24
55 R-1	128.93	249.47	123.50
58 I-1	81.02	31.62	49.23
58 C-1	-	-	110.53

TABLE IV-28

μg ATP/DRY G

Sample	March 28	April 25	May 16	May 27	July 2
39-1	1.07	1.18	1.16	1.17	1.05
39-2	1.03	-	-	1.00	1.04
39-3	1.02	-	-	0	1.04
50 J-C-1	1.87	1.18	1.21	1.66	1.17
50 J-C-2	1.10	-	-	-	-
50 J-I-1	1.19	1.30	1.21	1.29	1.03
50 J-I-2	1.17	-	-	1.26	-
55 R-1	1.08	1.29	1.21	1.12	-
55 R-2	1.05	-	-	1.05	-
55 R-3	1.03	-	-	1.08	-
58 I-1	1.27	1.19	1.21	1.40	-
58 I-2	1.11	-	-	1.14	-
58 I-3	1.08	-	-	1.14	-
58 C-1	-	-	-	-	-
58 C-2	1.06	-	-	-	-
58 C-3	-	-	-	-	-

Carbon and Nitrogen Analysis

The organic carbon and total nitrogen values are listed in Table IV-29. The carbon/nitrogen (C/N) ratios were also calculated. An overall decrease in C/N ratios took place between September and October, indicating that the litter decomposition process is rapid in the early fall. A significant decrease of organic carbon was seen at Station 50 J-C. The low overall C/N values are typical for an arid environment.

Fluctuations between sites in nitrate-nitrogen content were evident, with Station 55 R showing increases, 50 J-I remaining constant, and both Stations 39 and 58 I showing increases in lower profiles and decreases at the surface. There were significant decreases at Station 50 J-C. Extremely low values were prevalent throughout.

C. WORK SCHEDULED

1. VEGETATION

Work scheduled for the next quarter (December 1975 to February 1976) will consist of preparing analyses, comparisons, and interpretations for the First Year Environmental Baseline Report. In addition, data obtained from Utah Division of Wildlife Resources on plant phenology and microclimate will be summarized and prepared for reporting.

Preliminary plans for vegetation inventory scheduled in late spring will be made after a review of previously obtained data has been summarized in terms of statistical adequacy.

A sampling program for assessing reproduction rates will be developed. This will involve sampling seed production, seedling germination in the understory and relative numbers of one and two-year-old seedlings.

2. TERRESTRIAL VERTEBRATES

Attempts will be made to capture coyotes and bobcats as the opportunity arises. Deer movements will be followed through the radio monitoring program. Sheep use on the tracts will be monitored by aerial flights.

TABLE IV-29

CARBON/NITROGEN ANALYSIS

	Organic Carbon Percent		Total Nitrogen Percent		C:N Ratio		Nitrate-Nitrogen μg/g (=ppm)	
Sample	12 Sept. 1975	13 Oct. 1975	12 Sept. 1975	13 Oct. 1975	12 Sept. 1975	13 Oct. 1975	12 Sept. 1975	13 Oct. 1975
39-1	.62	.47	.05	.06	12.40	7.83	3.70	1.1
39-2	.44	.40	.04	.04	11.00	10.0	.50	.80
39-3	.38	.36	.03	.04	12.67	9.0	.90	1.0
50 J-I-1	1.90	1.64	.14	.17	13.57	9.65	2.10	2.10
50 J-I-2	-	-	-	-	-	-	-	-
50 J-L	25.00	-	.47	-	53.19	-	-	-
50 J-C-1	4.60	1.95	.14	.14	32.86	13.93	3.20	.80
50 J-C-2	-	-	-	-	-	-	-	-
55 R-1	1.21	1.01	.05	.07	24.20	14.43	.30	.60
55 R-2	.58	.84	.04	.06	14.50	14.00	.20	.50
55 R-3	.49	.43	.04	.04	12.25	10.75	.20	.30
58 I-1	.53	.27	.05	.04	10.60	6.75	2.10	.80
58 I-2	.38	.23	.03	.03	12.67	7.67	.90	1.40
58 I-3	.35	.26	.03	.03	11.67	8.67	.50	1.20
58 C-1	.93	-	.08	-	11.63	-	6.80	-
58 C-2	.72	-	.05	-	14.40	-	1.90	-
58 C-3	.43	-	.03	-	14.33	-	1.00	-
39-L	-	-	-	-	-	-	-	-
55 R-L	-	-	-	-	-	-	-	-
58-L	-	-	-	-	-	-	-	-

The avifauna and mammal sampling program will be conducted this quarter. The reptile and amphibian program will be modified in 1976 to reduce sample bias and to obtain population estimates for prominent lizard species. Some additional work may be added in May when adult snakes are most active and in October when juvenile snakes are active.

3. TERRESTRIAL INVERTEBRATES

During the sixth quarter, insects of the orders Hymenoptera, Coleoptera, and Hemiptera will be identified at the species level. Difficult groups will be sent out for taxonomic determinations by specialists.

4. AQUATIC BIOLOGY

The site will be visited to make observations and qualitative collections in January or February, as conditions permit. The purpose of the visit will be to concentrate on defining winter stonefly populations. A 150-foot trammel net has been ordered to supplement information on the fishery resource. This device will be used in deep pools and eddies that are not accessible for seining or electro-shocking. This net will be used under the supervision of the Utah Division of Wildlife Resources.

5. MICROBIOLOGY

Conduction of laboratory analyses will continue.

V. GEOLOGY AND SOILS

A. WORK COMPLETED

1. SOILS

Soils mapping has been completed within a 1-mi perimeter and will be reported in the First Year Environmental Baseline Report. The soil infiltration study of soils on the tracts was completed this quarter.

2. GEOLOGY

Investigation and documentation of the presence or absence of land surface subsidence and/or emergence was completed for Tracts U-a and U-b.

From mid-September to mid-October 1975 a precise re-leveling survey was conducted on a series of 16 U.S. Coast and Geodetic Survey first-order benchmarks (originally surveyed in 1933-34). The survey route approximately followed State Route 45 for 46.5 km (28.9 mi). The northernmost benchmark was about 10 km (6.2 mi) north of Bonanza; the southernmost, about 3 km (1.8 mi) north of Dragon.

Standard precision field methods and equipment were used to conduct the survey, and no special arithmetical balancing techniques were applied to the results. The overall re-leveling was found to be accurate within first-order limits.

B. DATA SUMMARY

1. SOILS

The soil infiltration study was conducted to generate baseline data for evaluating major impacts of land use changes on the soils. These data will also be used with the soils map to estimate runoff volumes by applying the U.S. Soil Conservation Service runoff calculations.

A Rocky Mountain infiltrometer was used to generate runoff from small, movable 76-by-30-cm plots (0.23 sq m of soil surface coverage). Plots were installed by driving the

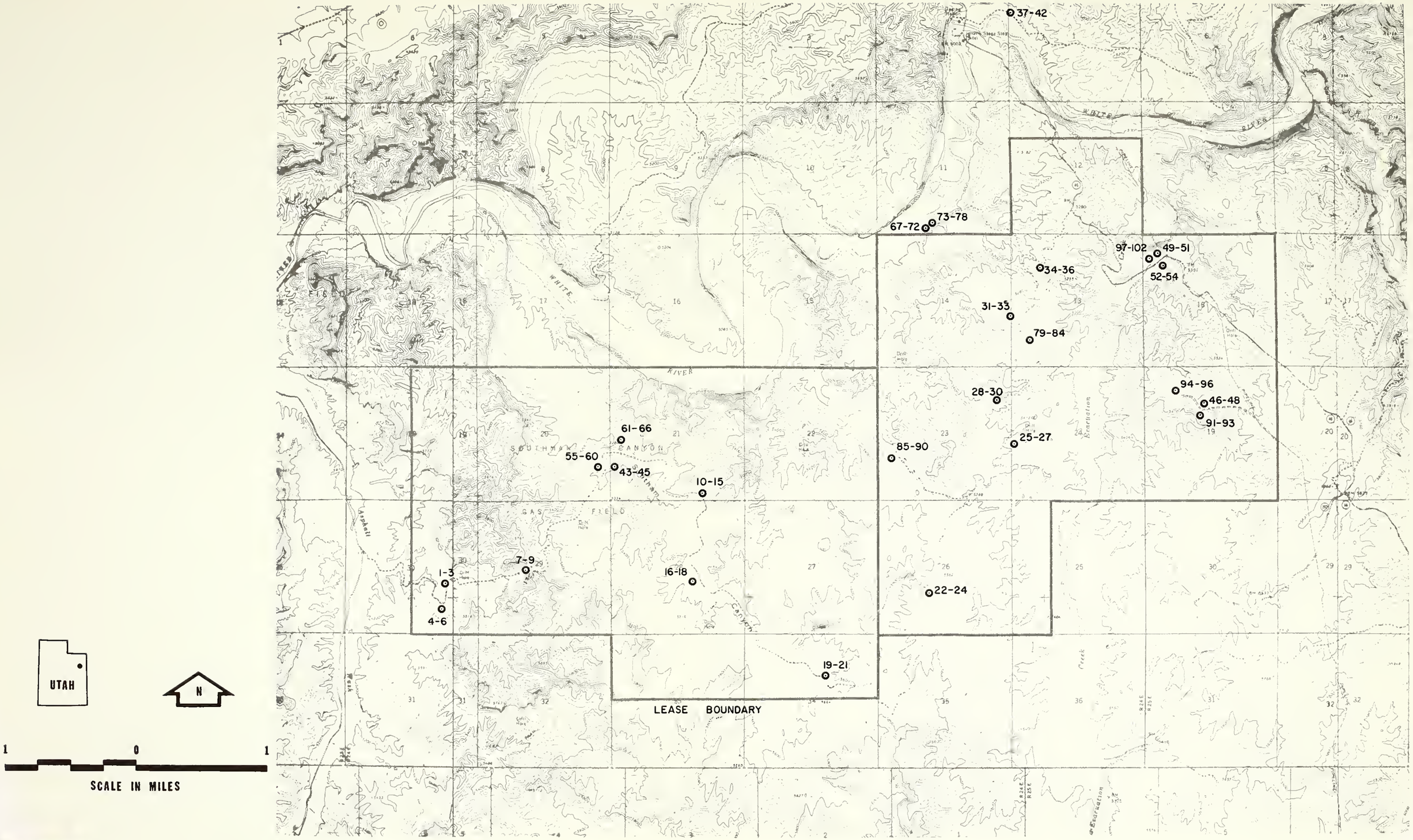
edges 9 cm into the soil surface with a specially constructed hammer. An adjustable canvas wind shield was used to prevent wind disturbance and raindrop drift. Plots were pre-wet to field capacity (called "wet plots") prior to an infiltrometer run. Artificial rainfall was applied to the plots at rates of 4 in. to 6 in. per hr for 28 min. Rainfall and runoff rates were determined at 5-min invervals, and infiltration was the difference between these two measurements. Sediment-yield values were also obtained. All samples were taken during October 1974 and October 1975. Sample points are shown on Figure V-1. The soils of most limited extent were not tested. A total of 96 plots were run.

Several limitations of these data must be considered. The principal limitation is the difficulty in simulating natural conditions with a small infiltration test device and the few sites tested. Also, seasonal variations in soil infiltration rates were not tested. The data provided is best used as a comparison between soil types.

Soil infiltration rates for wet soils are shown in Table V-1. Upland soils have rates of about 1.4 in. per hr. The soils of the bottomlands (D soils) have greater rates--about 2.4 in. per hour. The soils formed on the alluvium of the White River (W soils) have much slower rates of uptake--about 0.6 in. per hr. As expected, soils affected by excess sodium (N soils) have the lowest infiltration rates of all the soils tested--about 0.3 in. per hr.

Infiltration rates did not decrease significantly during the 28-min period of the test. Most runs showed no time trend. Runs that did show a decrease with time had small magnitudes, approximately 1/2 in. per hr, and were only apparent for the first 5 min of the run. In addition, soil type was apparently more significant in determining infiltration rates than was slope angle. For these reasons, infiltration data can be best summarized as a mean infiltration rate in each soil type. The rate of application was high to simulate severe storms. Because infiltration rates tend to be lowest in the fall and because the applied rates were high, runoff values should be maximum.

Curve number means and sediment yield rates are also shown in Table V-1. The curve numbers can be used to calculate runoff using the SCS method. The rates are highly variable, and as a result, the standard deviations are large. Estimates of sediment yield are used primarily as a comparison between soils.



LOCATIONS OF SOIL INFILTRATION PLOTS

FIGURE V-1

TABLE V-1

SUMMARY OF SOIL INFILTRATION RATES

	Mean Infiltration	Std. Dev.	Mean CN	Std. Dev.	Mean Sediment Yield	Std. Dev.
D_s (wet)	2.44	.75	85.67	9.80	.29	.25
B_s (wet)	1.48	.70	92.08	3.03	.65	1.02
A (wet)	1.26	.41	94.42	2.15	.21	.31
A_s (wet)	1.03	.58	95.50	1.64	.11	.07
W (wet)	.64	.46	96.67	1.51	.09	.05
N (wet)	.30	.29	98.50	1.22	.17	.13
F (wet)	1.91	.46	89.17	4.36	.05	.01
E (wet)	1.78	.75	89.83	5.08	.05	.03
B (wet)	.78	.39	96.42	1.73	.08	.05
D (dry)	2.41	.74	89.17	6.49	.16	.09
B_s (dry)	2.84	.51	86.33	.57	.46	.23

SOURCE: VTN

A few sites were not wetted before testing. These dry sites provided some information on the infiltration rates of soils when there was little antecedent moisture. Infiltration rates on dry soil were a fraction of an inch per hour slower than wet rates on the same plots.

Finally, these tests do not evaluate the pollution potential of spent shales. That potential is not dependent on the existing soils, but on the nature of the spent shale itself. When large quantities of spent shale (from processing) become available, further tests will be necessary.

Infiltration rates, curve numbers, and sediment yields are shown in Table V-2 for all 96 plots.

2. GEOLOGY

The greatest elevation difference between original and re-leveled values at any of the benchmarks was 3.6 cm (0.118 ft). It was concluded, however, that closing errors in both the original and re-leveling survey accounted for this elevation decrease; therefore, the re-leveling survey produced no evidence of definable localized subsidence or uplift during the last half century. If any such movement is occurring, it is at an exceedingly slow rate.

C. WORK SCHEDULED

1. SOILS

The soil infiltration study has been completed.

2. GEOLOGY

A 1.6-km (1-mi) grid pattern was suggested as appropriate for monitoring possible subsidence resulting from underground mining. This grid should extend to about 1.6 km outside the tract boundaries. The tract configurations indicate that a total of 40 to 45 stations will be required to complete the proposed pattern. Where existing section corners are suitably monumented and accessible, they may be used as subsidence stations.

TABLE V-2

Infiltration Rates During Various Time Intervals (minutes) By Plot Measured in Inches per Hour

Map Unit	Plot #	3-8	8-13	13-18	18-23	23-28	CN	Sediment Yield	% Bare Soil
				D_s Soil (Wet)					
D_sB	1	2.7	2.9	2.7	2.4	2.5	90	0.25	28
D_sB	2	3.4	3.2	3.0	2.8	2.6	95	0.20	"
D_sB	3	2.9	2.8	3.1	2.7	2.9	82	0.03	"
D_sB	7	1.9	1.5	1.8	1.4	1.5	94	0.38	16
D_sB	8	1.6	1.7	1.6	1.5	1.4	95	0.79	"
D_sB	9	1.9	1.5	1.3	1.5	1.1	93	0.33	"
D_sB	10	1.5	1.3	1.4	1.4	1.5	94	0.32	21
D_sB	11	1.4	1.3	1.7	1.5	1.4	95	0.67	"
D_sB	12	2.1	2.0	2.2	2.1	2.3	92	0.78	"
D_sB	13	2.8	2.2	2.7	2.3	1.9	90	0.34	19
D_sB	14	3.1	3.1	3.0	3.1	2.7	85	0.25	"
D_sB	15	2.5	2.4	2.2	2.1	2.1	90	0.28	"
D_sB	16	3.1	2.9	2.8	2.4	2.6	81	0.01	30
D_sB	17	4.1	3.4	3.4	3.4	2.9	62	0.00	"
D_sB	18	3.4	2.7	2.8	2.4	2.0	67	0.00	"
D_sB	19	3.5	4.1	2.9	2.7	2.7	80	0.09	65
D_sB	20	3.9	4.1	3.2	3.7	3.5	80	0.17	"
D_sB	21	2.8	2.8	2.0	2.1	2.2	77	0.28	"
				B_s Soil (Wet)					
B_sB	25	0.8	0.6	0.8	0.6	0.7	92	0.69	39
B_sB	26	2.3	0.8	1.0	0.7	0.7	90	0.80	"
B_sB	27	1.7	0.8	1.0	0.6	0.7	96	0.57	"
B_sC	22	1.6	1.0	1.1	1.4	1.0	95	0.86	60
B_sC	23	1.8	1.4	1.5	1.5	1.5	89	0.59	"
B_sC	24	2.1	2.2	2.1	1.9	1.7	88	0.23	"
B_sC	61	1.9	1.3	1.1	0.9	0.9	93	0.12	36
B_sC	62	1.4	1.3	1.0	1.0	1.1	95	0.12	"
B_sC	63	1.8	1.9	1.1	1.1	1.5	93	0.09	"
B_sC	64	2.8	1.1	1.0	1.3	1.7	93	0.21	"
B_sC	65	1.9	1.1	1.4	1.0	1.0	91	0.32	"
B_sC	66	1.7	1.1	1.0	1.3	1.1	94	0.07	"
B_sD	4	2.5	2.4	2.1	2.4	2.3	88	0.42	12
B_sD	5	1.5	1.3	1.5	1.9	1.2	95	2.40	"
B_sD	6	2.0	1.6	1.8	2.0	1.9	91	0.42	"
B_sD	43	1.8	1.6	1.2	1.2	1.6	92	0.15	36
B_sD	44	1.1	0.9	1.1	1.1	1.7	94	----	"
B_sD	45	1.0	1.1	0.5	0.7	0.5	96	0.11	"

TABLE V-2
(cont.)

Infiltration Rates During Various Time Intervals (minutes) By Plot Measured in Inches per Hour

Map Unit	Plot #	3-8	8-13	13-18	18-23	23-28	CN	Sediment Yield	% Bare Soil
B_sD	28	3.7	3.1	3.7	3.4	2.6	86	0.59	43
B_sD	29	2.2	2.1	2.4	1.8	1.8	92	4.72	"
B_sD	30	4.0	2.0	2.5	2.0	1.7	88	2.02	"
B_sE	55	1.6	1.1	1.1	1.3	1.2	93	0.09	42
B_sE	56	1.2	0.7	0.8	0.7	0.8	96	0.21	"
B_sE	57	1.2	0.6	0.6	0.5	0.5	94	0.21	"
B_sE	59	2.6	2.3	2.6	1.8	1.9	86	0.12	"
B_sE	60	1.2	0.8	0.9	0.9	1.4	94	0.15	"
				A Soil (Wet)					
AB	49	1.5	1.5	1.1	1.4	1.3	92	0.04	18
AB	50	1.5	1.2	1.0	1.2	1.0	94	0.05	"
AB	51	1.6	1.1	1.1	1.1	1.1	97	0.05	"
AC	46	0.9	0.9	0.9	1.1	1.2	96	0.06	46
AC	47	1.7	1.7	1.9	1.9	2.0	92	0.12	"
AC	48	1.2	1.1	1.1	1.1	1.1	95	0.06	"
AD	34	2.3	2.2	1.9	1.8	1.7	91	0.26	9
AD	35	1.5	1.1	1.1	1.0	0.9	96	1.14	"
AD	36	1.8	1.5	1.2	1.1	1.0	95	0.43	"
AD	52	1.1	0.6	0.8	0.7	0.6	97	0.11	33
AD	53	0.6	1.9	0.6	0.6	0.5	96	0.13	"
AD	54	1.4	1.5	1.2	1.3	1.3	92	0.06	"
				A_s Soil (Wet)					
A_sC	85	1.5	1.1	1.0	2.5	0.9	93	0.07	35
A_sC	86	1.2	1.7	1.6	2.4	1.2	94	0.05	"
A_sC	87	0.7	0.5	0.7	0.8	0.5	97	0.07	"
A_sC	88	0.6	0	0.9	0.9	0.4	96	0.17	"
A_sC	89	0.8	0.6	0.7	0.6	0.9	97	0.21	"
A_sC	90	1.2	1.3	0.7	0.7	1.2	96	0.07	"
				W Soil (Wet)					
W	37	0.8	0.6	0.5	0.6	0.6	97	0.09	48
W	38	0.9	0.3	0	0	0	98	0.18	"
W	39	0.7	0.8	0.8	0.6	0.6	97	0.11	"
W	40	1.6	0.7	0.8	0.7	0.8	94	0.05	"
W	41	0.4	0	0.5	0	0.9	98	0.07	"
W	42	2.2	0.9	1.0	0.5	0.5	96	0.04	"

TABLE V-2
(cont.)

Infiltration Rates During Various Time Intervals (minutes) By Plot Measured in Inches per Hour

Map Unit	Plot #	3-8	8-13	13-18	18-23	23-28	CN	Sediment Yield	% Bare Soil
				N Soil (Wet)					
NB	73	0.4	0.1	0.1	0.3	0.1	98	0.07	100
NB	79	0	0	0	0.1	0	100	0.10	"
NB	75	0.3	0.2	0.2	0.3	0.4	98	0.09	"
NB	76	0	0	0.1	0	0	100	0.10	"
NB	77	0.5	0.9	0.4	0.5	0.5	97	0.29	"
NB	78	0.9	0.9	0.7	0.7	0.3	98	0.38	"
				F Soil (Wet)					
F	79	2.1	2.0	1.3	1.7	1.6	91	0.06	44
F	80	1.5	1.6	1.6	1.3	1.4	94	0.04	"
F	81	2.5	2.4	2.3	2.4	2.5	84	0.07	"
F	82	2.8	2.4	2.4	2.4	2.2	84	0.04	"
F	83	1.7	1.6	1.5	1.3	1.2	93	0.05	"
F	89	2.5	2.0	1.7	1.9	1.6	89	0.06	"
				E Soil (Wet)					
EB	67	3.0	3.5	1.5	1.5	1.5	86	0.02	"
EB	68	3.7	2.2	2.2	1.9	1.8	86	0.03	"
EB	69	2.8	1.9	2.0	1.7	1.9	85	0.03	"
EB	70	1.2	1.3	0.7	1.1	0.9	96	0.08	"
EB	71	2.3	2.3	1.9	1.7	1.7	90	0.09	"
EB	72	1.1	0.8	1.2	0.9	1.1	96	0.05	"
				B Soil (Wet)					
BB	97	0.6	0.4	0.6	0.5	0.6	97	0.07	23
BB	98	0.7	0.5	0.6	0.5	0.6	98	0.07	"
BB	99	0.6	0.2	0.1	0	0	99	0.08	"
BB	100	1.6	0.8	0.5	0.6	0.6	96	0.05	"
BB	101	1.9	0.9	0.9	0.9	0.9	94	0.03	"
BB	102	0.9	0.8	0.7	0.7	1.2	97	0.05	"
BD	91	1.1	0.6	0.7	0.4	0.4	97	0.08	19
BD	92	1.4	1.4	1.3	1.3	1.1	95	0.03	"
BD	93	1.5	1.5	1.4	1.3	0.9	93	0.03	"
BD	94	0.6	0.6	0.5	0.7	0.6	97	0.20	"
BD	95	0.7	0.8	0.6	0.6	0.5	98	0.09	"
BD	96	1.1	0.8	0.7	0.6	0.8	96	0.12	"

TABLE V-2
(cont.)

Infiltration Rates During Various Time Intervals (minutes) By Plot Measured in Inches per Hour

Map Unit	Plot #	3-8	8-13	13-18	18-23	23-28	CN	Sediment Yield	% Bare Soil
				D Soil (Dry)					
D	1	3.0	3.2	2.6	2.7	2.2	92	0.20	28
D	2	3.4	3.2	3.0	2.8	2.6	87	0.15	"
D	3	3.9	2.8	3.0	2.9	3.3	77	0.01	"
D	7	2.7	1.8	2.2	1.6	1.5	94	0.18	16
D	8	2.5	1.9	1.7	1.5	1.4	94	0.27	"
D	9	3.0	2.0	1.5	1.3	1.2	91	0.16	"
				B_s Soil (Dry)					
B_sD	4	3.0	2.9	3.0	3.0	2.4	87	0.22	12
B_sD	5	3.6	3.4	2.8	2.6	2.5	86	0.47	"
B_sD	6	3.5	2.7	3.3	1.8	2.1	86	0.68	"

These stations need not all be established before initial mining begins. An area to be mined should be equipped with monitoring stations about one year before mining commences in that area. Stations in the spent shale disposal area should also be established one year in advance of disposal.

VI. HISTORIC AND SCIENTIFIC RESOURCES

A. WORK COMPLETED

As reported in the fourth quarterly report, the inventory and evaluation of historical, archaeological, and paleontological resources are complete. No further work was done for this quarter.

B. DATA SUMMARY

Not applicable.

C. WORK SCHEDULED

It is expected that only field walk-overs will be conducted during the next quarter to identify the oil shale plant facilities' proposed locations and their proximity to the scientific resources found on and off-site.

VII. REVEGETATION STUDIES

A. WORK COMPLETED

1. RESEEDING DRILL SITES

Drill-site reseeding on and off the tracts was completed. The sites will require maximum protection for reseeding to be successful. The program was initiated October 29 and completed November 8. Revegetation procedures as outlined in Quarterly Report No. 4 were altered and approved by the AOSS and are as follows.

Site G-17 (On Tract)

Spread straw, mulched in (approximately 6 in) seed by broadcasting and disked lightly, used four bales of straw (rate: 1 ton/acre).

Seed used:

Indian ricegrass (*Oryzopsis hymenoides*)	1/4 lb
Pubescent wheatgrass (*Agropyron trachycaulum*)	1/4 lb
Squirreltail (*Sitanion hystrix*)	1/4 lb
Alkali sacaton (*Sporobolus airoides consimilis*)	1/4 lb
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	1/4 lb
Black sagebrush (*Artemisia nova*)	1/4 lb
Big sagebrush (*Artemisia tridentata*)	1/4 lb
Douglas rabbitbrush (*Chrysothamnus viscidiflorus*)	1/4 lb

Site P-1 (On Tract)

Ripped on contour, spread straw, mulched in straw 4 to 6 in, seed by broadcasting, disked lightly, used 86 bales of straw (rate: 2 ton/acre).

Seed used:

Fairway wheatgrass (*Agropyron cristatum*)	4 lbs
Russian wildrye (*Elymus junceus*)	4 lbs
Yellow sweetclover (*Melilotus officinalis*)	4 lbs
Squirreltail (*Sitanion hystrix*)	3 lbs
Indian ricegrass (*Oryzopsis hymenoides*)	4 lbs
Douglas rabbitbrush (*Chrysothamnus viscidiflorus*)	3 lbs
Rubber rabbitbrush (*Chrysothamnus nauseosus consimilis*)	3 lbs
Black sagebrush (*Artemisia nova*)	3 lbs
Big sagebrush (*Artemisia tridentata*)	3 lbs

Site X-5 (On Tract)

Spread straw, mulched in (approximately 6 in), broadcast seed, harrowed lightly, used 14 bales of straw (rate: 2 ton/acre), disked road.

Seed used:

Indian ricegrass	1/2 lb
Pubescent wheatgrass	1/2 lb
Squirreltail	1/2 lb
Alkali sacaton	1/2 lb
Douglas rabbitbrush	1/2 lb
Black sagebrush	1/2 lb
Big sagebrush	1/2 lb
Rubber rabbitbrush	1/2 lb

Site X-4 (On Tract)

Spread straw, mulched in (approximately 6 in), broadcast seed, harrowed lightly, used 16 bales of straw (rate: 2 ton/acre), disked around old well head.

Seed used:

Fairway wheatgrass	1/2 lb
Russian wildrye	1/2 lb
Yellow sweetclover	1/2 lb
Squirreltail	1/4 lb
Indian ricegrass	1/4 lb
Douglas rabbitbrush	1/4 lb
Rubber rabbitbrush	1/4 lb
Black sagebrush	1/4 lb
Big sagebrush	1/4 lb

Site G-5 (On Tract)

Spread straw, mulched in (approximately 6 in), broadcast seed, harrowed and used six bales of straw (rate: 1 ton/acre).

Seed used:

Indian ricegrass	1/4 lb
Pubescent wheatgrass	1/4 lb
Squirreltail	1/4 lb
Alkali sacaton	1/4 lb
Douglas rabbitbrush	1/4 lb
Black sagebrush	1/4 lb
Rubber rabbitbrush	1/4 lb

Site G-7 and P-3 (Off Tract)

Spread straw, lightly mulched straw in (approximately 2 in), drilled seed in, disked up roadway. Ralph Heft (of the BLM) advised that the straw not be mulched in as deeply as on the above locations. From now on all locations will be mulched with 128 bales of straw (rate: 1 ton/acre).

Seed used:

Indian ricegrass	3 lbs
Pubescent wheatgrass	3 lbs
Squirreltail	1 1/2 lbs
Alkali sacaton	1 1/2 lbs
Douglas rabbitbrush	1 1/2 lbs
Black sagebrush	1 1/2 lbs
Big sagebrush	1 1/2 lbs
Rubber rabbitbrush	1 1/2 lbs

Site G-4 and G-15 (On Tract)

Spread straw, lightly mulched straw (2 to 3 in), drilled seed, disked up road, used 40 bales of straw (rate: 1 ton/acre).

Seed used:

Fairway wheatgrass	1/2 lb
Russian wildrye	1/2 lb
Yellow sweetclover	1/4 lb
Squirreltail	1/4 lb
Indian ricegrass	1/4 lb
Douglas rabbitbrush	1/4 lb
Rubber rabbitbrush	1/4 lb
Black sagebrush	1/4 lb
Big sagebrush	1/4 lb

Site X-10 (On Tract)

Spread straw, lightly mulched (approximately 3 in), broadcast seed, lightly disked over seed, using 24 bales of straw (rate: 1 ton/acre) also 1 lb of four-wing saltbrush.

Seed used:

Indian ricegrass	2 lbs
Pubescent wheatgrass	2 lbs
Squirreltail	2 lbs
Alkali sacaton	2 lbs
Douglas rabbitbrush	2 lbs
Black sagebrush	2 lbs
Big sagebrush	2 lbs
Rubber rabbitbrush	2 lbs

Site G-1 (On Tract)

Ripped location, spread straw, lightly mulched, broadcast seed, broadcast nitrogen fertilizer (15 lbs), used 12 bales of straw (rate: 1 1/2 ton/acre). Above applied to east half of location between road and well.

Ripped location, applied 525 lbs of sawdust and 15 lbs nitrogen, drilled seed and rolled location. This is west half of location.

Seed used:

Fairway wheatgrass	1/2 lb
Russian wildrye	1/2 lb
Yellow sweetclover	1/4 lb
Squirreltail	1/4 lb
Indian ricegrass	1/4 lb
Douglas rabbitbrush	1/4 lb
Rubber rabbitbrush	1/4 lb
Black sagebrush	1/4 lb
Big sagebrush	1/4 lb

Fertilizer used was nitrogen 21 percent in ammonia form and sulphur 24 percent (combined)

Site P-2 (On Tract)

Ripped location, spread straw, lightly mulched, broadcast seed, disked lightly, used 66 bales of straw (rate: 2 ton/acre).

Seed used:

Indian ricegrass	2 1/2 lbs
Pubescent wheatgrass	2 1/2 lbs
Squirreltail	2 1/2 lbs
Alkali sacaton	2 1/2 lbs
Douglas rabbitbrush	2 1/2 lbs
Black sagebrush	2 1/2 lbs
Big sagebrush	2 1/2 lbs
Rubber rabbitbrush	2 1/2 lbs

Site G-8 (On Tract)

Ripped location, spread straw, lightly disked in, broadcast seed and lightly disked, used 14 bales of straw (rate: 2 ton/ acre).

Seed used:

Fairway wheatgrass	1 1/2 lbs
Russian wildrye	2 lbs
Yellow sweetclover	1 lb
Squirreltail	1/2 lb
Indian ricegrass	1/2 lb
Douglas rabbitbrush	1/2 lb
Rubber rabbitbrush	1/2 lb
Black sagebrush	1/2 lb
Big sagebrush	1/2 lb

Site X-3 (On Tract)

Spread straw, disk lightly, broadcast seed, lightly disk, used 16 bales of straw (rate: 1 ton/acre).

Seed used:

Fairway wheatgrass	1/2 lb
Russian wildrye	1/2 lb
Yellow sweetclover	1/2 lb
Squirreltail	1/2 lb
Indian ricegrass	1/2 lb
Douglas rabbitbrush	1/2 lb
Rubber rabbitbrush	1/2 lb
Black sagebrush	1/2 lb
Big sagebrush	1/2 lb

Note: This location has a lot of shale rock on the surface of the ground.

Site P-4 (On Tract)

Spread straw, lightly disked in, seed by broadcasting and disk lightly. This method applied on road section outside of fence. Used 43 bales of straw on location and 11 bales on road (rate: 2 ton/acre).

Seed used:

Indian ricegrass	4 lbs
Pubescent wheatgrass	5 lbs
Squirreltail	2 1/2 lbs
Alkali sacaton	2 1/2 lbs
Douglas rabbitbrush	2 1/2 lbs
Black sagebrush	2 1/2 lbs
Big sagebrush	2 1/2 lbs
Rubber rabbitbrush	2 1/2 lbs

Note: This location also has shale rock on surface of ground.

Site G-6 and G-19 (Off Tract, BLM)

Ripped location, disked, seed by broadcasting, lightly disked and spread juniper and sagebrush mulch and set nine rabbitbrush and two four-wing saltbushes on location.

Seed used:

Fairway wheatgrass	2 1/4 lbs
Russian wildrye	3 lbs
Yellow sweetclover	1 1/2 lbs
Squirreltail	3/4 lb
Indian ricegrass	3/4 lb
Douglas rabbitbrush	3/4 lb
Rubber rabbitbrush	3/4 lb
Black sagebrush	3/4 lb
Big sagebrush	3/4 lb

On November 11, 1975, various reseeded sites were inspected. In attendance for the inspection were--

Mr. Jerry McMillan--Casada Const. Co.
Mr. Dave Moore--BLM, Vernal
Mr. Dave Oberwager--AOSO, Grand Junction
Mr. Bob Elderkin--AOSO, Grand Junction
Mr. Neal Godwin--VTN, Denver

The following are selected photographs of some of the sites visited. (Figures VII-1 to VII-9.)

2. REVEGETATION RESEARCH

Continued research into revegetation of processed shale disposal areas in Utah was assured when the White River Shale Project (WRSP) and the Utah State University-Agricultural Experiment Station (USU-AES) signed a contract November 5, 1975. This research program is to be completed December 31, 1977. A preliminary program of studies by USU-AES was previously funded by the WRSP through VTN Colorado, Inc. for an eight-month period.

The purpose of the research is to develop a method of revegetating disturbed sites and processed shale disposal areas with native plant species from the immediate region that require minimal maintenance. The research program is in response to conditions outlined in the Federal Register, Vol. 38, No. 230, Section 11-L. The general scope of the research program recognizes the following facts or conditions:

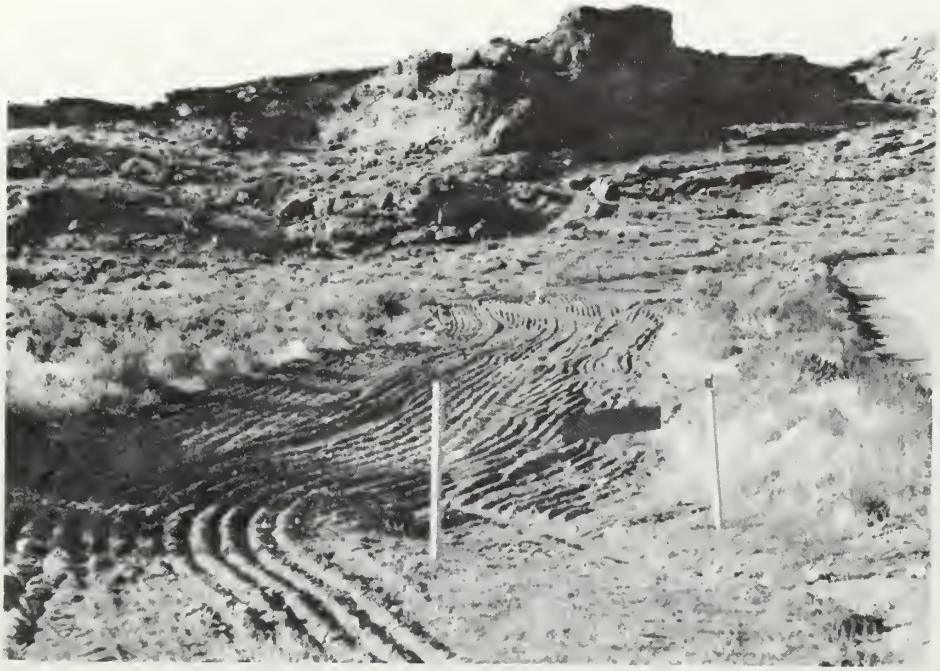


FIGURE VII-1

RESEEDED DRILL SITE G-17

FIGURE VII-2

P-1

FIGURE VII-3

X-5

FIGURE VII-4

G-7 AND P-3

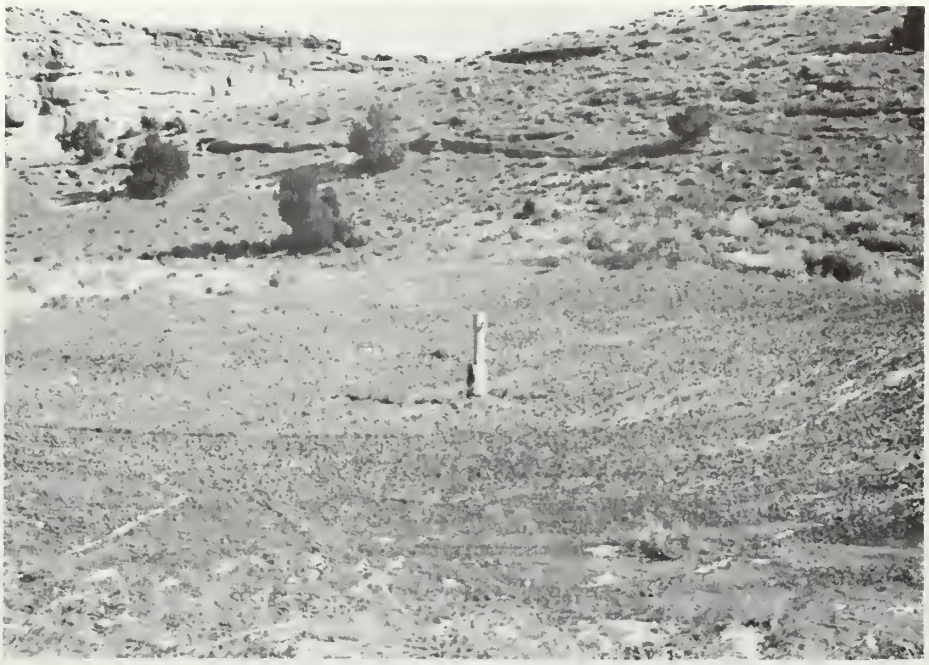


FIGURE VII-5

G-5

FIGURE VII-6

X-9

FIGURE VII-7

P-2

FIGURE VII-8

P-4

FIGURE VII-9

G-6 AND G-19

a. Plants used in rehabilitating disturbed areas and processed shale must be adapted for persistence under existing conditions.

b. Water is a scarce resource in the oil shale area, and any use of it for revegetation must be minimal.

c. Salinity in the processed shale is a serious problem for plant growth and because of the possibility of saline leachates getting into the drainage system.

d. Surface dust may be a problem.

e. Revegetation of salt desert shrub ecosy tems by direct seeding with exotic grasses has not record of previous success.

B. DATA SUMMARY

1. RESEEDING DRILL SITES

Not applicable.

2. REVEGETATION RESEARCH

Not applicable.

C. WORK SCHEDULED

1. RESEEDED DRILL SITES

The reseeded drill site will be identified with signs as protection from further disturbance.

2. REVEGETATION RESEARCH

The research program will be directed towards evaluating and developing successful techniques of propagating drought-tolerant and salinity-tolerant native plants, especially shrubs; developing methods of transplanting container-grown plants directly into processed shale in trenches or columns of soil; evaluating and selecting appropriate soil-surface

stabilizing agents that will assist in water harvesting and reduction of salinity concentration in the root zone; and documenting the persistence of transplanted species and invading plants under various intensities of care. Consultation and coordination during the early planning and development phases of the project will be an integral part of the program.

VIII. GEOLOGICAL EXPLORATION PROGRAM

A. WORK COMPLETED

1. OBJECTIVES

In preparation for the DDP, the lessees proposed drilling eleven core holes to supplement the initial seven holes drilled for the original exploration program and the three pilot test holes drilled for the ground water hydrology program. The specific objectives of the drilling program were as follows:

1) Determine the oil shale grade throughout the tracts
2) Determine whether major fault offsets occur in the oil shale mining zone
3) Determine the principal partings, joints, and fracture systems in the oil shale mining zone and their continuity within the tracts
4) Determine structural attitudes of the strata
5) Provide core samples for strength of materials testing for initial mine planning and design
6) Provide additional subsurface hydrologic data

The core hole locations chosen afforded maximum use of existing roads and approximately one-mile spacing between all core holes. Maximum geological and engineering data yield versus minimal environmental impact were also considered.

Geophysical logs were proposed for each drill hole completed and were to include the following:

1) Compensation formation density log (gamma-gamma density)
2) Natural gamma-ray log
3) Caliper log
4) Laterolog resistivity log (electrode contact-type resistivity log)
5) Spontaneous potential log
6) Sonic log
7) Compensated neutron log
8) Production log (flow meter and temperature)

Drill cuttings were to be collected at 10-foot intervals, except for cored intervals. Oil-yield assays were to be run on 1-foot increments of the core using the Modified Fischer Retort method. Analyses for nahcolite were to be run if identified in the core. Raw and spent shale

samples were to be analyzed for other minerals and trace elements as required. Portions of the recovered core were to be used for physical rock-testing.

Rock mechanics investigations for the evaluation of the physical characteristics of the groundmass immediately above, within, and immediately below, the oil shale zone were deemed necessary to provide design criteria for underground mine development. Proposed were deformation tests, uniaxial and triaxial compression tests to destruction, Brazilian tests, and density determination.

2. METHODOLOGY

Nine of the eleven proposed exploration core holes and four instead of three pilot test holes were drilled, and lithologic logs were prepared for them. Proposed Holes X-7 and X-8 were eliminated by the AOSS because of their proximity to the pilot test holes. Geophysical logging as proposed in the exploration plan was completed for these 13 holes.

Composite samples from 100-foot intervals within and adjacent to the mining zone were analyzed for boron, mercury, cadmium, fluoride, antimony, arsenic, selenium, and molybdenum. These analyses were performed on samples from Holes X-2, X-3, X-4, X-5, X-6, X-9, X-10, and X-11. Raw and spent shale were similarly analyzed (except for molybdenum) at six or seven 100-foot intervals for Holes P-1, P-2, P-3, and P-4. The spent shale samples were analyzed for the portions of the elements that were water soluble and for the total element contained. Raw shale was analyzed for the total element contained.

Spent shale from the pilot test holes and exploration holes were analyzed at 10-foot intervals for extractable alumina. Nahcolite found in the drill hole lithologic logs was analyzed for sodium bicarbonate content.

The approximate location of the mining zone was determined from the boring logs. The contact between the Green River Formation and the overlying Uinta Formation was identified by studying lithologic and geophysical logs. The locations of fractures and principal partings were indicated on the lithologic logs. These data have not been analyzed.

VTN geologists used the geophysical logs to prepare a structural contour map (see Quarterly Report No. 4, Figure V-6) and to determine the structural attitude of the strata. The strata were found to be relatively uniform, striking

NNE-SSW to NE-SW with an average dip of 6 1/2° NW, and to have no major fault offsets.

The exploration core holes were used to monitor static water levels and to determine accurately the location of the bird's nest aquifer. The holes are still open to their entire depth to develop a gas monitoring study during 1976. Water quality samples were not extracted because the bird's nest aquifer was not isolated.

Cleveland Cliffs Iron Company (CCIC) turned over to the WRSP and the AOSS the results of several tests not included in this baseline report. Selected intervals within and near the mining zone were assayed and tested for rock mechanics properties, and tests now are 98 percent complete.

B. DATA SUMMARY

Copies of the lithologic logs for the holes drilled are in the field-data summary of the fifth quarterly report. The intervals cored are as follows:

Hole	Depth of Cored Interval from Surface
P-1	615 ft - 914 ft
P-2	573 ft - 1039 ft
P-3	582 ft - 1099 ft
P-4	390 ft - 918 ft
X-1	870 ft - 1140 ft
X-2	460 ft - 766 ft
X-3	321 ft - 591 ft
X-4	660 ft - 958 ft
X-5	652 ft - 935 ft
X-6	510 ft - 805 ft
X-9	800 ft - 1052 ft
X-10	840 ft - 1097 ft
X-11	691 ft - 1023 ft

Spent shale was analyzed for extractable alumina to determine whether the alumina could be extracted economically and used. The complete results of this analysis are contained in the CCIC report. The range of alumina concentrations within the mining zone was found to be 0.054 percent to 1.420 percent. CCIC concluded that this concentration was low and that it would not be economically beneficial to extract alumina from the spent shale.

Nahcolite concentrations were also tested to determine whether it could be extracted economically and used.

Nahcolite found at five locations within the mining zone totaled 4.72 ft thick with an average concentration of about 35 percent. CCIC concluded that nahcolite was present in only a few small scattered cavities within the mining zone and that it would not be economically beneficial to extract.

The approximate location of the mining zone was determined in relation to the mahogany marker. The roof will be located on a natural parting plant 20 to 25 ft above the marker. The floor will also be located on a parting plane, 35 to 40 ft below the marker.

The depth of the contact between the Green River and Uinta formations was determined for easier correlation among the bore holes. Depths to contact in each bore hole are as follows:

P-1	199 ft
P-2	370 ft
P-3	265 ft
P-4	180 ft
X-1	470 ft
X-2	104 ft
X-4	299 ft
X-5	324 ft
X-6	185 ft
X-9	413 ft
X-10	396 ft
X-11	335 ft

C. WORK SCHEDULED

The U. S. Bureau of Mines in Denver is conducting 30-day creep tests on core samples. The results will be available in one to three months.

Results of the heavy metal tests will be published in the next quarterly report as analyzed by CCIC as well as other pertinent data essential to the environmental baseline collection program.

The WRSP is reviewing plans for additional geologic exploration work. This work might include additional core holes to supplement the data already compiled.

IX. AESTHETICS

A. WORK COMPLETED

1. DEFINITION

Aesthetic resources are physical and cultural landscape elements perceived by humans through sight, sound, smell, touch, and taste, moderated by emotional, cognitive, and evaluative responses. The principal users of the area are employees connected with the project; residents of Bonanza, Utah; and occasional recreationalists who visit the area for hunting, fishing, rockhounding, river rafting, and general sight-seeing.

2. METHODOLOGY

Tracts U-a and U-b and a 1-mile fringe around them were divided into mappable landscape units comprising perceptual input from natural and man-made aesthetic resources. A landscape unit is characterized by an assemblage of natural processes that show form, color, scale, texture, light, motion, sound, touch, smell, and perhaps taste. A landscape unit can be positively or negatively accentuated by contrasting features, termed "deviations," such as a windmill, a rock pinnacle, or a pipeline.

3. THE REGIONAL AESTHETIC SETTING

The boundary landforms around the Uinta Basin are the primary aesthetic resources of the region. The most accessible of these are the Uinta Mountains, the Book Cliffs, the Wasatch Plateau, Flaming Gorge National Recreation Area, Dinosaur National Monument, and the Green River. The landscapes are diverse, from the glacier-scoured Uinta Mountains to the river-cut Split Mountain in Dinosaur National Monument. The area is known as "red rock country," indicating the dominant color perception. Distant views are common, and sounds are non-irritating because of few urban-industrial influences. In the region surrounding Tracts U-a and U-b the dust, daily extremes in temperature, and dryness influence the perception of aesthetic resources.

4. TRACTS U-a AND U-b AESTHETIC SETTING

The three landscape units defined for Tracts U-a and U-b are the ridgetop-basin complex, the canyons, and the White River. These units will be considered separately. The three units are shown in Figure IX-1.

a. The Ridgetop-Basin Landscape Unit

The ridgetop-basin complex includes areas with superior views of the surrounding landscape. (See Figures IX-2 and IX-3.) The best views are from the ridges serving as drainage divides between Asphalt Wash and Southam Canyon and Southam Canyon and Evacuation Creek and from the ridges overlooking tributary basins to the White River. These areas afford spectacular panoramic views that reveal the distinct contrast between the brown-to-buff-colored Uinta Formation and the underlying Green River Formation and its numerous strata, which give a horizontal linear pattern to the light gray unit. The views are so distant that the aesthetic experience is primarily visual. The views are highlighted at sunrise, when individual buttes and ridge walls are lit up, and at sunset, when the canyons are in shadow. (See Figures IX-4 and IX-5.) In contrast, the setting on the ridgetops is dominated by unusual micro-landforms like lichen, ancient ripple marks, precipitation cusps in rock, honeycombed appearance of some calcareous rock, and seedling pinyon trees. (See Figures IX-6 through IX-9.)

Lizards, snakes, mourning doves, deer, cottontail, and mice are often seen, as are soaring raptors such as the turkey vulture in summer, and golden eagles in winter and spring. In addition, many owls can be seen at night. Numerous rock pinnacles, waterpockets, balanced rocks, and rock windows are the most prominent unique geologic features. (See Figures IX-10 and IX-11.) These include Castle Rock and Duck Rock, which are accessible from the main improved dirt road that runs from Ignacio Bridge to Southam Canyon. (See Figures IX-12 and IX-13.) The environment on the ridgetops is usually quiet, and visibility is usually excellent. Water pockets form in shallow rock depressions on the mesa tops and give added diversity. Most areas in this unit are accessible by short hikes from the improved dirt roads or by driving directly over a drainage divide like the road from Southam Canyon to Asphalt Wash.

LEGEND

LANDSCAPE UNITS

WR - WHITE RIVER
C - CANYON
RB - RIDGETOP-BASIN COMPLEX

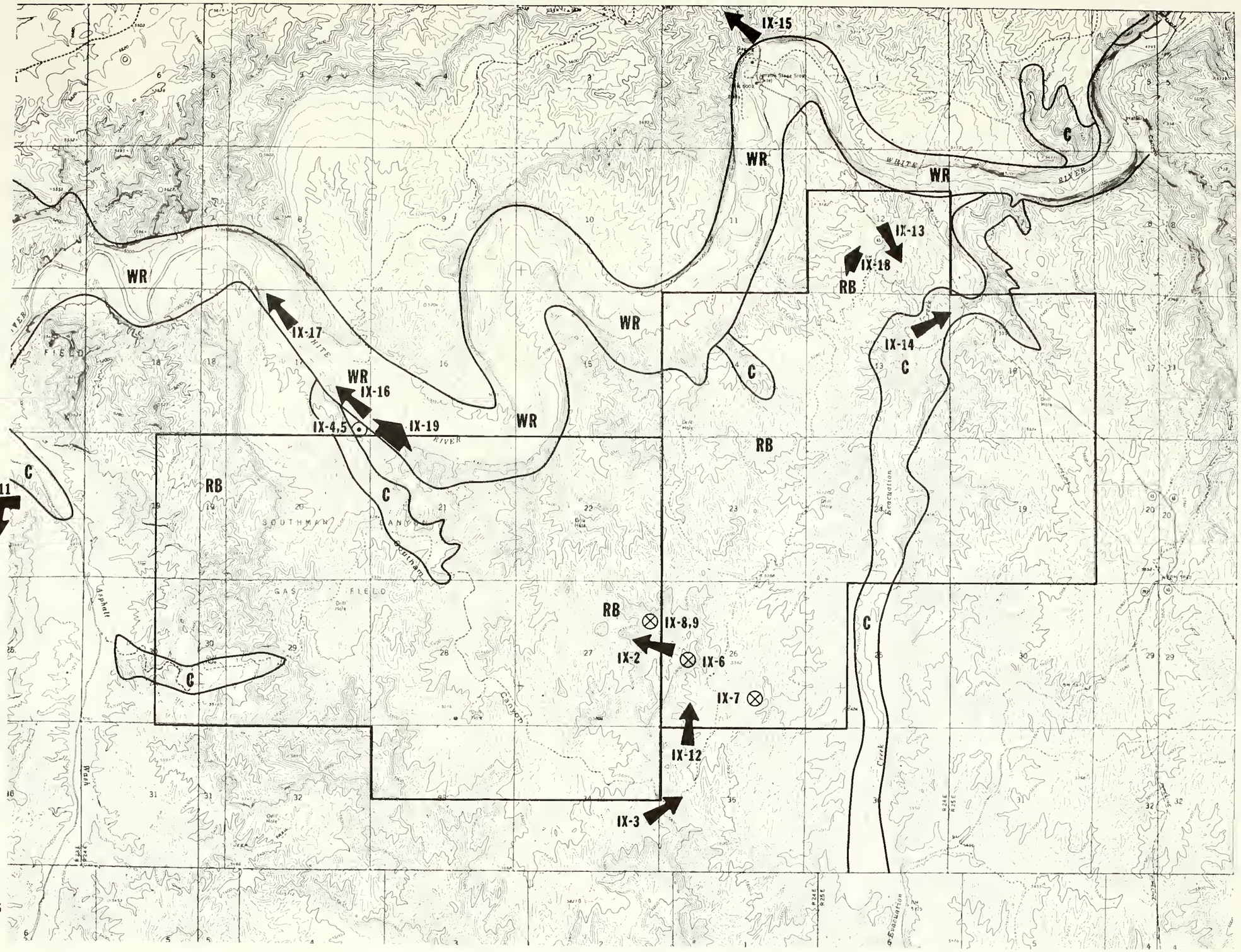
PHOTOGRAPH ORIENTATION

DIRECTION OF PHOTO WITH FIGURE NUMBER

PHOTO DIRECTION IS VERTICALLY UPWARD

PHOTO DIRECTION IS VERTICALLY DOWNWARD

PANORAMA OF SEVERAL PHOTOGRAPHS WITH ANGLE OF VIEW MEASURED BY ANGLE AT VORTEX



LANDSCAPE UNITS & PHOTOGRAPH ORIENTATIONS FOR EVALUATING AESTHETIC RESOURCES

FIGURE IX-1

FIGURE IX-2
(PLUS-X, 1/250, F. 11, F.L. inf.)
SOUTHAM CANYON

FIGURE IX-3
(PLUS-X, 1/500, F. 16, F.L. inf.)
RIDGETOP VEGETATION

THESE ARE PANORAMIC VIEWS CHARACTERISTIC OF THE RIDGETOP-BASIN LANDSCAPE UNIT. THE TOP PHOTO WAS TAKEN ON THE RIDGE OVERLOOKING SOUTHAM CANYON, WHILE THE LOWER PHOTO DEMONSTRATES THE SPARSENESS OF VEGETATION, A FACTOR THAT GIVES GREATER EMPHASIS TO GEOLOGIC FEATURES. REFER TO FIGURE IX-1 FOR EXACT LOCATION OF PHOTOGRAPHER POSITION AND DIRECTION OF AIM FOR ALL PHOTOS.

FIGURE IX-4
(PLUS-X, 1/30, F. 2, F.L. inf.)
SUNRISE

FIGURE IX-5
(PLUS-X, 1/30, F. 2, F. L. inf.)
SUNRISE

THESE ARE PHOTOS OF THE SUNRISE TAKEN FROM A RIDGETOP OVERLOOKING THE WHITE RIVER. CLOUD PATTERNS ARE FREQUENTLY DIVERSE AND WIDESPREAD IN THE EARLY MORNING.

FIGURE IX-6
(PLUS-X, 1/125, F. 6, F.L. 3m.)
PINYON TREE

FIGURE IX-7
(PLUS-X, 1/125, F. 8, F.L. 3m.)
WATERPOCKETS

THESE PHOTOS ILLUSTRATE THE UNIQUE DETAIL PREVELENT ON RIDGETOPS AND SUPPLEMENTING THE PANORAMIC VIEWS. THE TOP PHOTO IS A PINYON TREE SPLIT BY LIGHTNING, AND THE BOTTOM PHOTO IS AN EXAMPLE OF THE WATERPOCKETS THAT ADD WATER, A RARE ELEMENT OF THE LANDSCAPE.

FIGURE IX-8
(PLUS-X, 1/250, F 2, F.L. 0.8m.)
GEOLOGIC DETAIL

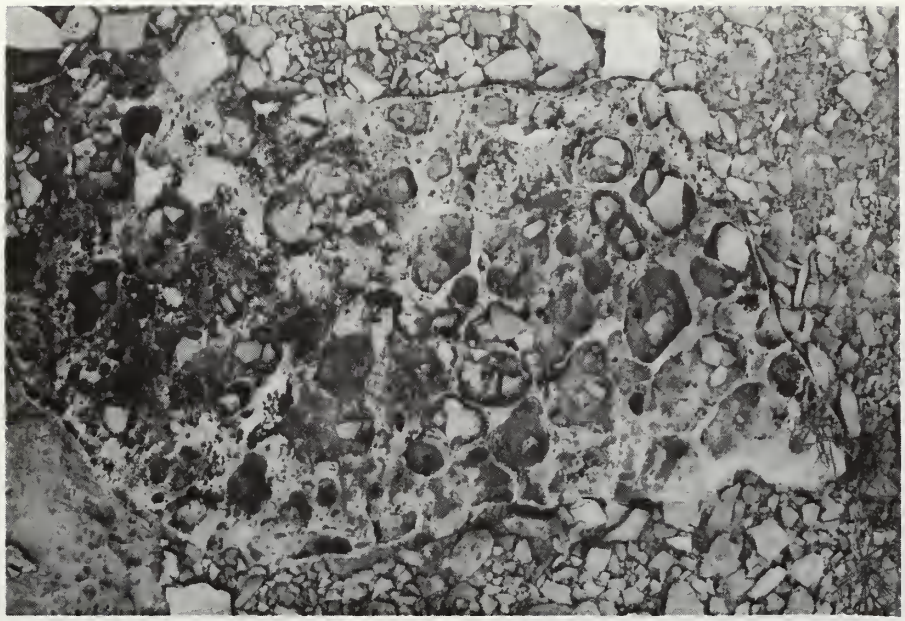
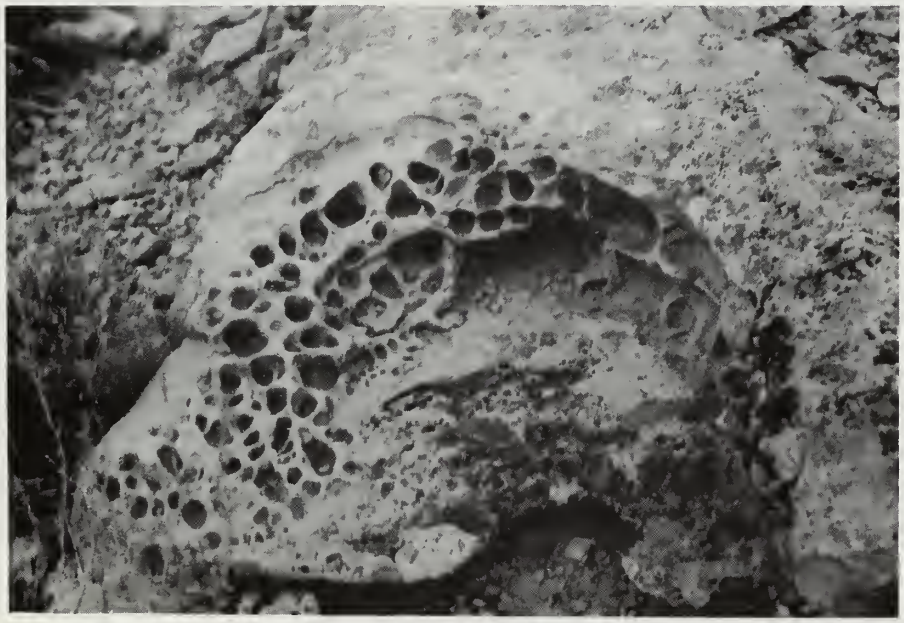


FIGURE IX-9
(PLUS-X, 1/250, F 2, F.L. 0.8m.)
GEOLOGIC DETAIL



THESE TWO PHOTOS TAKEN ON THE RIDGETOP OVERLOOKING SOUTHAM CANYON PROVIDE FURTHER EXAMPLES OF THE DETAIL IN GEOLOGIC DESIGN.

FIGURE IX-10
(PLUS-X, 1/125, F. 6, F.L. inf.)
BALANCED ROCK

FIGURE IX-11
(PLUS-X, 1/125, F 6, F.L. inf.)
BALANCED ROCK

THESE TWO PHOTOS SHOW BALANCED ROCK AT TWO SCALES. THE ROCK IS A VISUAL HIGHLIGHT TO THE WEST RIDGE OF ASPHALT WASH, CONSISTING OF A ROCK APPROXIMATELY 3M BY 3M BY 2M (9.8 FT X 9.8 FT X 5.6 FT) SUPPORTED BY A BOULDER THE SIZE OF A SMALL WATERMELON.

FIGURE IX-12
(PLUS-X, 1/250, F.8, F.L. 10m.)
ROCK WINDOWS

FIGURE IX-13
(PLUS-X, 1/250, F.16, F.L. inf.)
DUCK ROCK

ROCK WINDOWS ARE A CONTRAST TO THE LAND/SKY INTERFACE, AS ILLUSTRATED BY THE WINDOW (ABOVE) FOUND IN THE SOUTHEAST CORNER OF TRACT U-b, AND BY DUCK ROCK (BELOW), WHICH IS VISABLE FROM THE EXISTING DIRT ROAD (UTAH HIGHWAY 45) ENTERING TRACT U-a SOUTH OF IGNATIO STAGE STOP.

b. The Canyon Landscape Unit

The canyon areas include Evacuation Creek, lower Southam Canyon, Asphalt Wash, and all steep-walled tributaries to these drainages and to the White River. Because the water-land interface is such a dominant element in the White River canyon, this area will be considered separately. The canyon landscape unit is characterized by enclosed views enhanced by geologic detail, micro-changes in vegetation, and water in ephemeral stream courses. (See Figures IX-14 and IX-15.) A variety of unusual cavities and swallow nests along the rock walls below the protruding ledges associated with the Green River Formation give Evacuation Creek canyon a coarse, honey-combed appearance. The bird's nest aquifer outcrops here, and many birds have built nests in the cavities. Soaring birds are occasionally seen gliding with the mid-morning convective wind currents far above the canyon walls.

The nearly vertical walls focus attention in the canyon and along the sharp boundary between the walls and the usually clear Utah sky. The canyons meander with the stream channel; this is accentuated toward their downstream portions, thus decreasing the length of view. Consequently, attention is focused on detail. A distinctive white bed of volcanic ash with a sandstone texture is visible along the walls of Evacuation Creek. Quicksand is encountered in the creekbed where the bird's nest aquifer discharges water into the stream's sandy alluvium. Bubbles of relatively clear ground water boil up through the sand or along the edge of the creekbed and form pools. This is an extreme contrast to the turbid stormflow subsequent to summer thunderstorms and spring runoff.

Desert varnish, composed of the reds, blues, and blacks of oxides of iron and manganese, gives a tapestried appearance to canyon walls and overhanging ledges. Mudflows have also streaked the walls.

In contrast to Southam Canyon, Asphalt Wash, and tributaries to the White River, Evacuation Creek has more confined views, more frequent streamflow, and more vegetation types, including the more colorful riparian associations. Southam Canyon has fewer enclosed views, and Asphalt Wash has fewer meanders and is in a more symmetrical valley.

c. The White River Landscape Unit

Since the White River is the most prominent feature and the only perennial stream on Tracts U-a and U-b and within

FIGURE IX-14
(PLUS-X, 1/125, F. 11.5, F.L. inf.)
EVACUATION CREEK

FIGURE IX-15
(PLUS-X, 1/125, F. 14, F.L. inf.)
CANYON WALL CAVITIES

THESE TWO ENCLOSED VIEWS ARE CHARACTERISTIC OF THE CANYON LANDSCAPE UNIT. THE TOP PHOTO IS LOOKING EAST, FACING DOWNSTREAM ON EVACUATION CREEK, AND THE LOWER PHOTO, TAKEN ALONG THE ACCESS ROAD ENTERING TRACT U-a, IS AN EXAMPLE OF THE NUMEROUS CAVITIES FOUND ON CANYON WALLS.

a one-mile radius, it is considered as a separate landscape unit. Although the views are characteristically enclosed within canyon walls, considerable detail and movement can be observed from the river itself. (See Figures IX-16 and IX-17.) The canyon walls are steep and in places are composed of stream-cut facets with large vertical relief and vertical joint and fracture lines superimposed on the horizontal bedding stratifications. The land-water interface along the river is a continuation of point bars protruding from the canyon walls and cut banks on the opposite side of the river. Thinly laminated silt beds on the bars and alluvial deposits of various sizes are exposed on the cut banks as a cross-section of the river's history. Rock ledges, rock windows, rock alcoves, and recent rockfalls are common. The highest ridge visible from the river is in sharp, jagged contrast with the sky. (See Figures IX-18 and IX-19.)

Channel bars, snags, and driftwood are common in the river. Beaver dams and their occupants are sometimes seen. Lower point bars show evidence of meander scars, which emphasize the sinusoidal nature of the channel pattern. The more stable point bars are thickly vegetated with green cottonwoods. Cattle and sheep frequently occupy these riparian areas, and may be seen occasionally, particularly east of Ignacio Bridge.

Many small insects, grasshoppers, and racer snakes appear frequently along the stream banks. Ducks, Canada geese, various shorebirds, and soaring raptors add to the aesthetic setting. Dilapidated cabins that once belonged to shepherds are visible from the river 3 km (2 mi.) downstream at Ignacio Bridge. An abandoned oil shale mine and trestle are visible between the mouths of Hells Hole Canyon and Evacuation Creek on the north side of the river. Although the river is extremely turbid, reflections of sunlight can often be seen from the bridge or from the riffles during sunrise. At sunset, long shadows on the river emphasize ridgeform and vegetation shapes.

Two seasonal aspects of the aesthetic setting along the White River especially highlight visual appreciation of Tracts U-a and U-b. In the winter, the river freezes and forms a white band of ice that winds through the canyon. In the fall, some of the riparian vegetation turns red, orange, and yellow and contrasts with evergreen shrubs and trees.

B. DATA SUMMARY

The Uinta Basin and Tracts U-a and U-b are characterized by

FIGURE IX-16
(PLUS-X, 1/250, F.16, F.L. inf.)
WHITE RIVER

FIGURE IX-17
(PLUS-X, 1/250, F.16, F.L. inf.)
WHITE RIVER VEGETATION

THESE TWO VIEWS ARE COMMON IN THE WHITE RIVER LANDSCAPE UNIT, ILLUSTRATING THE ARRAY OF FLUVIAL LANDFORMS AND CONTRAST IN VEGETATION TYPES.

FIGURE IX-18
(PLUS-X, 1/500, F. 16, F.L. inf.)

PANORAMIC VIEWS OF THE WHITE RIVER PROVIDE THE MOST UNIQUE, CONTRASTING, AND DIVERSE SETTINGS FOR INDIVIDUAL PERCEPTION OF AESTHETIC RESOURCES. THE LAND/SKY INTERFACE IS SHARP AND SUCH VIEWS CONSTITUTE EXCELLENT OBSERVATION POINTS WHEN SEARCHING FOR RAPTORS, LARGE MAMMALS, AND OTHER WILDLIFE OF AESTHETIC INTEREST. COLOR AND FORM ARE THE DOMINANT ELEMENTS IN THESE PANORAMAS, WHICH ENCOMPASS VIEWS OF 55° AND 175°.

FIGURE IX-19
(PLUS-X, 1/125, F. 12, F.L. inf.)

a variety of aesthetic resources. The landforms surrounding the basin--the Uinta Mountains, the Book Cliffs, the Wasatch Plateau, and the Green River--are the primary and most accessible features. Although the tracts are a harsh, arid environment subject to climatic extremes, they nevertheless contain an abundance of unusual and interesting aesthetic features. Elevated landforms and clear air afford spectacular panoramic views devoid of human influence. The many unique geologic formations set against the clear Utah sky, include rock windows, balanced rocks, odd rock shapes, monoliths, and multi-patterned canyon walls. Closer inspection of many of these formations reveals micro-landforms and patterns. In contrast to the sparsely-vegetated desert scenery is the White River and its lush riparian areas.

The tracts were divided into three distinct landscape units--the ridgetop-basin complex, the canyons, and the White River. The most pleasing feature of the ridgetop-basin-unit is the spectacular panoramic views of the surrounding landscape and unique geologic features that can be seen from the ridgetops. The ridgetops themselves are characterized by unusual micro-landforms.

The canyon areas include Evacuation Creek, lower Southam Canyon, Asphalt Wash, and are steep-walled tributaries to these drainages and to the White River. The landscape is characterized by vegetation, water in ephemeral streams, and unusual geologic detail, such as the protruding ledges of the Green River Formation and the nahcolite formations of the bird's nest aquifer outcrops.

The White River, the only perennial stream on the tracts, is enclosed within canyon walls. The thick vegetation and cottonwood trees along the river are often occupied by cattle and sheep. These riparian areas are a pleasing contrast to the sparse vegetation and stark geological detail of the surrounding area.

In summary, no one landscape unit as described can be designated more aesthetically sensitive then the other. The oil shale tracts and the region surrounding them are diverse and unique, and any areas proposed for commercial development (i.e., retort site, spent shale disposal site, roads, power lines, etc.) should be judged individually or collectively to fully evaluate the aesthetic impact or significance.

C. WORK SCHEDULED

The work is complete and ready for review by the OSEAP and the AOSSO.

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(June 1984)

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TN 859 .U82 W418 no.5

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Environmental Baselir

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